Filed on behalf of: Google Inc.

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GOOGLE INC.
Petitioner

v.

SILVER STATE INTELLECTUAL TECHNOLOGIES, INC.
Patent Owner

U.S. Patent No. 7,650,234

DECLARATION OF DR. WILLIAM R. MICHALSON

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I, William R. Michalson, declare as follows:

I. INTRODUCTION

1. I have been retained by Google Inc. as an independent expert consultant in this proceeding before the United States Patent and Trademark Office ("PTO") regarding U.S. Patent No. 7,650,234 ("the '234 patent," which I understand is Ex. 1001 in this proceeding). I have been asked to consider whether certain references disclose the features recited in claims 1-30 of the '234 patent. My opinions are set forth below.

2. I am being compensated at my rate of $450 per hour for the time I spend on this matter, and no part of my compensation is dependent on the outcome of this proceeding. I have no other interest in this proceeding.

II. QUALIFICATIONS

3. I received my Ph.D. in Electrical Engineering from Worcester Polytechnic Institute in 1989, my Master of Science in Electrical Engineering from Worcester Polytechnic Institute in 1985, and my Bachelor of Science in Electrical Engineering from Syracuse University in 1981.

4. I am currently a member of the faculty of the Electrical and Computer Engineering Department at the Worcester Polytechnic Institute in Massachusetts and have been a full-time faculty member there since 1991. I also have an appointment as a Professor of Computer Science and I am a founding member of

the faculty of the Robotics Program. My emphasis at Worcester Polytechnic is on teaching and conducting research on navigation, communications, and computer system design.

5. I was employed as an engineer at Raytheon Company from 1981 until 1991. During this period, I worked on a variety of projects which involved both hardware and software design, including those relating to satellite, airborne, and ground-based systems for navigation and communications. From 1985 until 1988, I received a fellowship from Raytheon to pursue my Ph.D. degree and worked part-time during this period. I returned to Raytheon full-time from 1988 until 1991.

6. I hold eight patents in the fields of audio signal processing, indoor geolocation devices, and handheld GPS (Global Positioning System) mapping devices. I have authored or co-authored over 100 original articles in the fields of communications networks, precision location systems, and GPS, including more than 15 journal papers and 90 conference papers. I am a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE).

7. I have worked in the field of computer architecture and computer systems since I began employment at Raytheon in 1981. In addition, I teach classes relating to computer architecture and design, and I also teach classes relating to embedded system designs, advanced system architectures, and real-time system designs. In addition, I teach classes in Electrical and Computer Engineering

Design, Foundations of Robotics and Robot Navigation. I have worked extensively in software programming, including during my employment at Raytheon and in a variety of projects relating to navigation and communications systems at Worcester Polytechnic Institute.

8. GPS and GPS-related technologies have dominated the bulk of my research since 1992. I have been involved in numerous academic and consulting projects involving navigation technologies and their association with geographic information system technologies. Examples of academic projects include (1) a container tracking system in 2003 which explored the application of tracking and communications technologies to track shipping containers, (2) an automotive based system in 2000 which combined GPS and map data in an automotive environment, (3) a remote hazard detection system in 1996 that combined GPS and radio communications to remotely identify hazards to the engineer operating a freight train, and (4) a differential GPS system in 1995 that combined GPS and radio technologies to allow determining the precise path of vehicles operating off-road during forest operations. As a consultant, I have worked with the combination of GPS and radio communications in the context of space shuttle docking operations, transfer of traffic information to GPS devices in a vehicle, combinations of GPS and cellular communications for the tracking of individuals, and map-based handheld tracking devices.

9. Based on my experience and education, I believe that I am qualified to opine as to knowledge and level of skill of one of ordinary skill in the art at the time of the alleged invention of the ’234 patent (which I further describe below) and what such a person would have understood at that time, and the state of the art during that time.

10. My curriculum vitae, which includes a more detailed summary of my background, experience, and publications, is attached as Appendix A.

III. SUMMARY OF OPINIONS

11. All of the opinions contained in this Declaration are based on the documents that I reviewed, my knowledge and experience, and professional judgment. In forming the opinions expressed in this Declaration, I reviewed the ’234 patent (Ex. 1001), the prosecution file history for the ’234 patent (which I understand is Ex. 1002 in this proceeding), U.S. Patent No. 6,401,027 to Xu et al. (“*Xu*”) (which I understand is Ex. 1004 in this proceeding), U.S. Patent No. 5,835,881 to Trovato et al. (“*Trovato*”) (which I understand is Ex. 1005 in this proceeding), U.S. Patent No. 6,442,391 to Johansson et al. (“*Johansson*”) (which I understand is Ex. 1005 in this proceeding), U.S. Patent No. 5,933,100 to Golding (“*Golding*”) (which I understand is Ex. 1006 in this proceeding), any other materials I refer to in this declaration in support of my opinions, while drawing on

my experience and knowledge of communications systems and location-based technology.

12. Based on my experience and expertise, it is my opinion that certain references disclose all the features recited in claims 1-30 of the ’234 patent, as I discuss in detail below.

13. Although this Declaration refers to selected portions of the cited references for the sake of brevity, it should be understood that one of ordinary skill in the art would view 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 entirety.

IV. LEVEL OF ORDINARY SKILL

14. Based on my knowledge and experience, I understand what a person of ordinary skill in the art would have known at the time of the alleged invention. I have, for example, taught, participated in organizations, and worked closely with many such persons over the course of my career. My opinions herein are, where appropriate, based on my understandings as to one of ordinary skill in the art at that time.

15. In my opinion, based on the materials and information that I have reviewed, and on my extensive experience in the technical areas relevant to the

’234 patent, a person of ordinary skill in the art would have been an engineer having at least a bachelor’s degree in electrical engineering, computer science, or a degree in a related field, with approximately two or more years of experience in the design and implementation of navigation systems and/or routing. I apply this understanding in my analysis herein.

V. THE ’234 PATENT

A. Overview of the ’234 Patent

16. The ’234 patent, entitled “Technique for Effective Navigation Based on User Preferences,” issued on January 19, 2010, from U.S. Application No. 11/971,193, which was filed on January 8, 2008. (Ex. 1001.) I have been asked to assume for purposes of this proceeding that the effective date of the ’234 patent is October 19, 1999, which is the filing date of a provisional application to which the ’234 patent claims priority. I apply this understanding in my analysis herein.

17. The ’234 patent is directed to a navigation system (e.g., “navigator arrangement 100”) that “may be ‘docked’ or connected to another device or system to enhance its functionality, which may include a terminal, workstation, computer system, or an automobile system.” (*Id.*, 3:29-33.) The “navigator arrangement 100 includes processor 103, memory 108, display driver 111, display 113, user interface 115, external interfaces 117, GPS receiver 119, communication unit 120.” (*Id.*, 3:36-39.) While databases in navigator arrangement 100 may be “pre-

populated with data" (*id.*, 4:30-32), data may also be downloaded "from a remote source to supplement and update the databases in arrangement 100, and to provide thereto just-in-time information, including, e.g., latest traffic, weather, map and other information" (*Id.*, 4:33-37).

18. Navigator arrangement 100 includes a "NAVIGATE option 657." (*Id.*, 9:56-57.) The NAVIGATE option provides the user with an interface to enter an origination and destination address, with the user's current location being the default origination. (*Id.*, 10:5-10.) According to the '234 patent, "[a]fter learning the origination address and destination address . . . processor 103 determines whether" a geographic area called the "navigation coverage" "includes the origination and destination addresses, and whether the stored map and related information is fresh." (*Id.*, 10:27-34.) "If the navigation coverage includes the origination and destination addresses in question . . . processor 103 at step 1006 selects the route from the origination address to the destination address which is the most time-efficient, i.e., fastest by automobile in this instance, taking into account the relevant weather, traffic, and road conditions along the selected route, together with any roadblocks set up by the user in a manner to be described." (*Id.*, 10:35-46.) On the other hand, if the "navigation coverage" area "does not cover the origination and/or destination address in question, and/or if the map and related information is not fresh, processor 103 . . . establishes a communication connection

to navigation server 630 [and] causes a transmission of a request for fresh map and related information for an appropriate navigation coverage through the established connection." (*Id.*, 10:55-61.)

19. The '234 patent includes four independent claims, claims 1, 9, 17, and 24. Claims 2-8 depend directly or indirectly from claim 1, claims 10-16 depend directly or indirectly from claim 9, claims 18-23 depend directly or indirectly from claim 17, and claims 25-30 depend directly or indirectly from claim 24.

20. In my opinion, as explained further below, the features recited in claims 1-30 characterize conventional features of vehicle navigation systems known prior to the time of the alleged invention for the '234 patent, e.g., as disclosed in *Xu*, *Golding*, and *Trovato*.

B. General Background

21. Route planning based on road conditions, such as traffic and weather information, has been a well-known feature of vehicle navigation systems since at least the early 1980s. For instance, by 1980, it was already recognized that "searching [for a route] can be carried out very quickly and at any time before or during a journey to meet changed or changing conditions, as forecast or actually met on the roads." (Ex. 1009, UK Patent Application GB 2079453A at 7:40-42.) Such changes could be initiated "[i]n the event that the driver finds that road, weather, or other conditions are undesirably impeding his progress along the

route," with a new route determined "avoiding the road sections ahead on which travelling difficulties are known (for example, from a broadcast traffic news bulletin) to exist." (*Id*. at 7:1-6).

22. By the late 1980s, systems were being developed that addressed the need to make route changes based on traffic congestion. "These systems [could] respond to traffic conditions, help drivers avoid incidents and traffic congestion and guide them to their precise destination." (Ex. 1010, Wootton, J.; Ness, M.; "The experience of developing and providing driver route information systems," IEEE 1989 Vehicle Navigation and Information Systems Conference, pp. 71-75, Toronto, Ont., Canada, 11-13 Sep 1989 at 74). "If information can be obtained in real time, for example on traffic incidents or congestion, then drivers might be advised of new routes to follow to their destination with the consequent reduced travel times." (*Id*., 71).

23. Likewise, systems were developed in which "an alternative route is calculated and displayed if signals from an IB (information beacon) advise of congestion or closure of the planned route." (Ex. 1011, Saito, T.; Shima, J.; Kanemitsu, H.; Tanaka, Y.; "Automobile navigation system using beacon information," IEEE 1989 Vehicle Navigation and Information Systems Conference, pp. 139-145, Toronto, 11-13 Sep 1989 at 142). "IB (information beacon) data concerning congestion is expressed as a congestion factor

(corresponding to link flow rate). When such information is received, the shortest route from the preceding node to D is calculated (as above) in terms of total link cost (distance x congestion factor) and displayed on the CRT.” (*Id.*, 143).

24. By the time *Xu*, *Golding*, and *Trovato* were filed in the mid-to-late 1990s, route planning based on road conditions for vehicle navigation systems was well established and well known to those of ordinary skill in the art.

VI. CLAIM CONSTRUCTION

25. I understand that a claim subject to *inter partes* review receives the broadest reasonable interpretation in light of the specification and file history of the patent in which it appears. I also understand that any term that is not construed should be given its plain and ordinary meaning under the broadest reasonable interpretation. I have followed these principles in my analysis. I discuss certain claim terms below and what I understand to be Petitioner’s construction of these terms, which I apply in my analysis. The remaining claim terms in the ’234 patent are given their plain and ordinary meaning under the broadest reasonable interpretation, which I also apply in my analysis.

26. I understand that Petitioner has proposed that the broadest reasonable interpretation of the claimed term “searching the database” is “analyzing data from the database.” I agree with this construction based on the claims and specification of the ’234 patent. For example, while the ’234 patent does not define or even use

the term “searching” anywhere in its specification, it does disclose a scenario in which a server analyzes data from a database (Ex. 1001 at 8:26-55), and a scenario in which data is transmitted from a database of a server to a processor of a “navigator arrangement” and then the data from the database is analyzed at the “navigator arrangement” (*id.*, 10:27-11:14). The common factor in both scenarios is that data from a database is analyzed. The construction is also consistent with my review of the file history and how one of ordinary skill in the art would have understood the term in context of the ’234 patent. I have applied this understanding in my analysis.

27. I understand that Petitioner has proposed that the broadest reasonable interpretation of the claimed term “navigation coverage” is “the geographic area over which the navigation system operates.” I agree with this construction based on the claims and specification of the ’234 patent. For example, the ’234 patent describes a scenario in which “processor 103 determines whether the **navigation coverage** based on the map layer corresponding to automobile travel . . . includes the origination and destination addresses in question.” (Ex. 1001 at 10:30-35 (emphasis added).) If so, “processor 103 . . . selects [a] route from the origination address to the destination address.” (*Id.*, 10:35-42.) However, “if the stored map . . . does not cover the origination and/or destination address in question . . . processor 103 causes a transmission of a request for fresh map and related

information **for an appropriate navigation coverage**." (*Id.*, 10:55-62 (emphasis added).) In other words, in the '234 patent, maps associated with an appropriate navigation coverage are selected to conform to the geographic area over which the navigation system operates. The construction is also consistent with my review of the file history and how one of ordinary skill in the art would have understood the term in context of the '234 patent. I have applied this understanding in my analysis.

28. I understand that Petitioner has proposed that the broadest reasonable interpretation of the claimed term "coverage area" is "the geographic area that the vehicle is located in, which is a subset of the geographic area over which the navigation system operates." I agree with this construction based on the claims and specification of the '234 patent. The term "coverage area" does not appear in the specification of the '234 patent. However, in the context of claims 1, 9, 17, and 24, "coverage area" is a subset of the navigation coverage, which is addressed above. For example, claim 1 refers to a "coverage area including the location of the navigation device." (*Id.*, 13:65-67.) Claim 1 also characterizes a scenario in which "the coverage area is different from one or more areas in navigation coverage defined by the origination and destination," suggesting that the "coverage area" is a subset of the overall navigation coverage. (*Id.*, 14:3-5.) Claims 9, 17, and 24 characterize the "coverage area" in substantively the same manner. The

construction is also consistent with my review of the file history and how one of ordinary skill in the art would have understood the term in context of the ’234 patent. I have applied this understanding in my analysis.

29. I have been asked to assume that the broadest reasonable interpretation of the “processing unit for searching the database for traffic information specific to a coverage area including the location of the vehicle” recited in claim 17, and the “processing unit for searching the database for weather information specific to a coverage area including the location of the vehicle” recited in claim 24, includes “a server, a processor of a navigation device, or equivalents thereof.” I have applied this understanding in my analysis.

VII. THE PRIOR ART DISCLOSES ALL OF THE FEATURES OF CLAIMS 1-30 THE ’234 PATENT

30. I have reviewed several references, discussed further below, that I understand are prior art to the ’234 patent. In my opinion, these references disclose all features of claims 1-30 of the ’234 patent.

A. Overview of *Xu*

31. *Xu* relates to “traffic data collection and intelligent routing systems for highway vehicles,” including a “system and method for remotely collecting real-time traffic data and providing traffic forecasts and travel guidance for drivers of vehicles equipped to utilize the system.” (Ex. 1004 at 1:6-11.) Figure 1, which I show below, illustrates one example of a “traffic data remote collection and

intelligent vehicle highway system" that performs a method for navigation. (*Id.*, 6:26-28.)

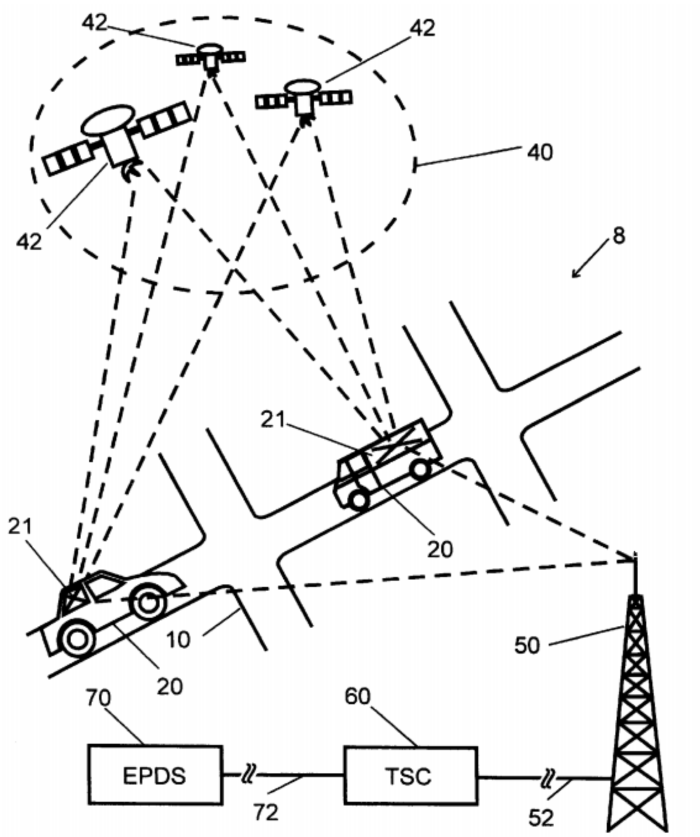


Figure 1

(*Id.*, 6:26-28, Fig. 1.)

32. The traffic data remote collection and intelligent vehicle highway system includes a "group of vehicles 20 [that] travel a roadway system 10." (*Id.*, 6:28-29.) An example of the roadway system 10 is shown in Figure 4:

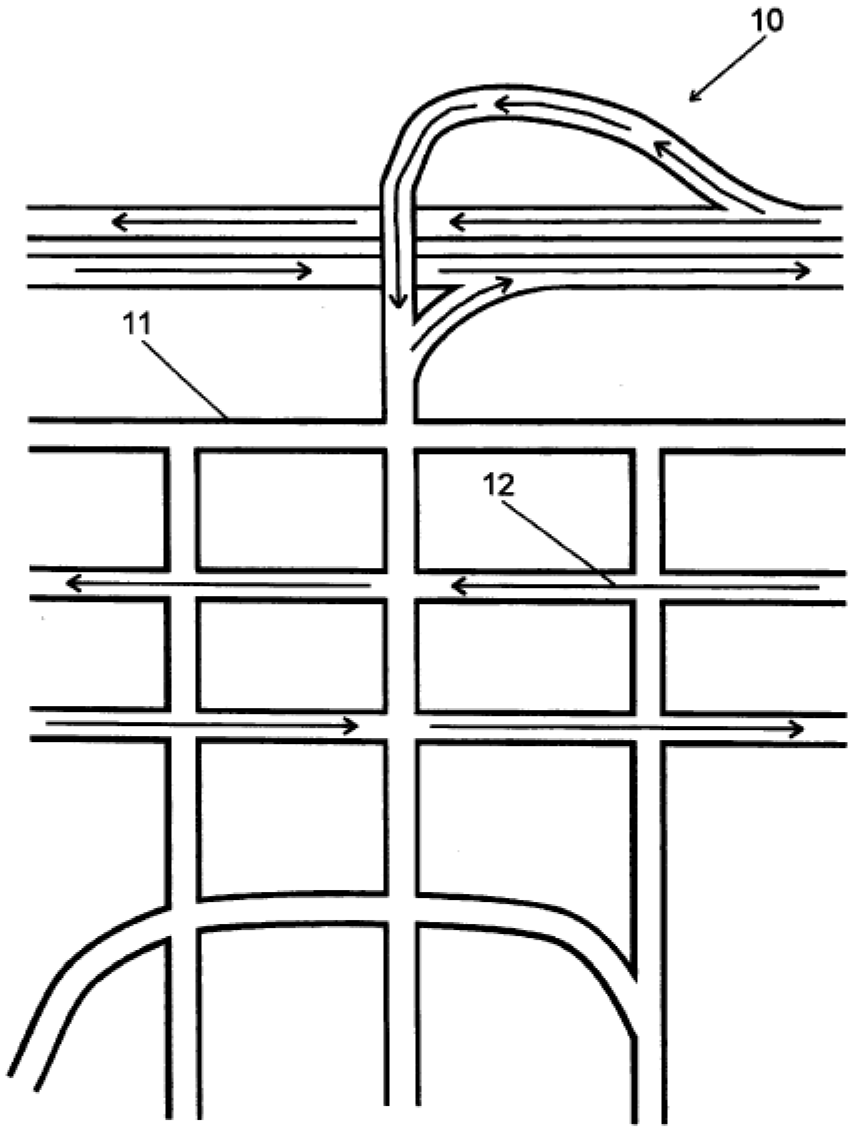


Figure 4

(*Id.*, 8:40-50, Fig. 4.) Figure 5 depicts an example of a digitized road network representing roadway system 10:

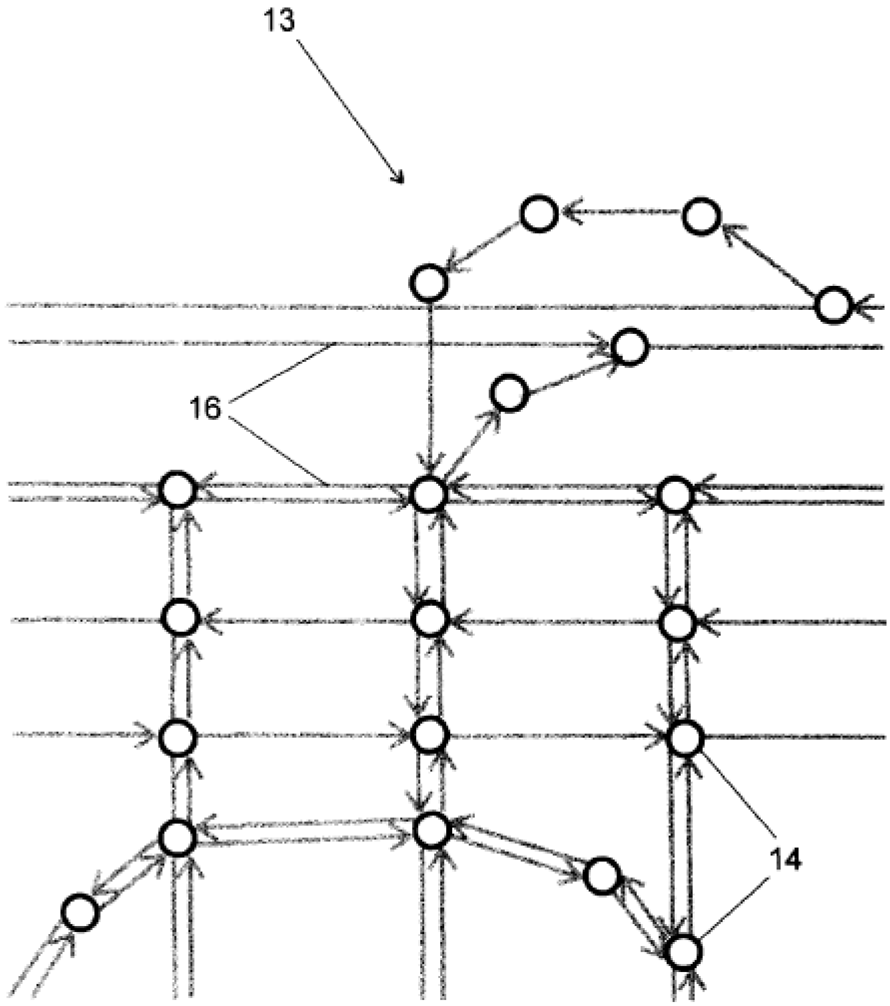


Figure 5

(*Id.*, 8:50-52, Fig. 5.)

33. "Each vehicle 20 is equipped with an in-vehicle device 21." (*Id.*, 6:31-32, Fig. 2 (reproduced below).)

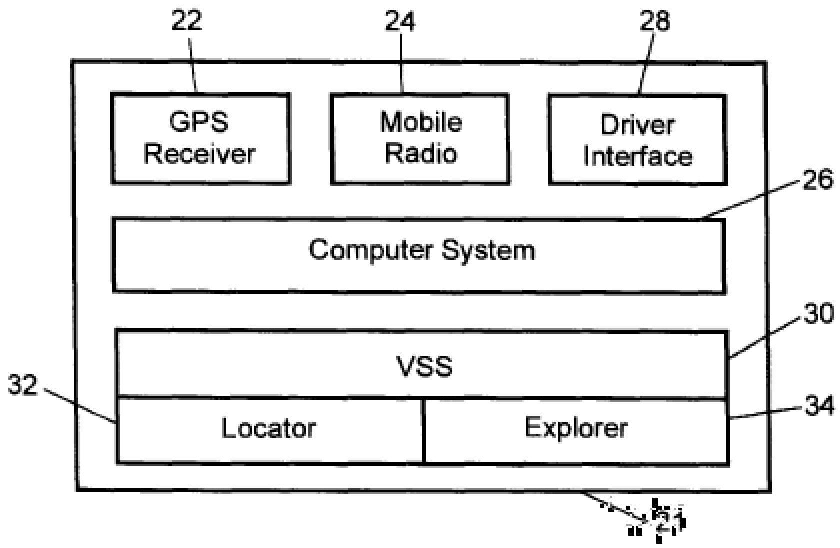


Figure 2

(*Id.*, Fig. 2.) The in-vehicle device 21 has a "vehicle support sub-system 30," which "includes a road network locator 32 (hereinafter locator 32) and a road explorer 34." (*Id.*, 7:21-23.) The in-vehicle device 21 also has a "computer system 26 for operating the sub-systems and storing the digitized road network map," as well as a "mobile radio sub-system 24 . . . for exchanging radio frequency data with [a] traffic service center 60," and a "driver interface 28 . . . to permit drivers to interact with the in-vehicle device 21." (*Id.*, 7:23-31.)

34. The "locator 32 computes the geographical location of the vehicle, using data received from [a] GPS receiver 22, and converts it to a position on the digitized road network map, which is broadcast from the traffic service center 60 via the communication station 50 and stored in the computer system 26." (*Id.*, 7:32-37; *see also id.*, Fig. 3 (depicting the traffic service center 60).)

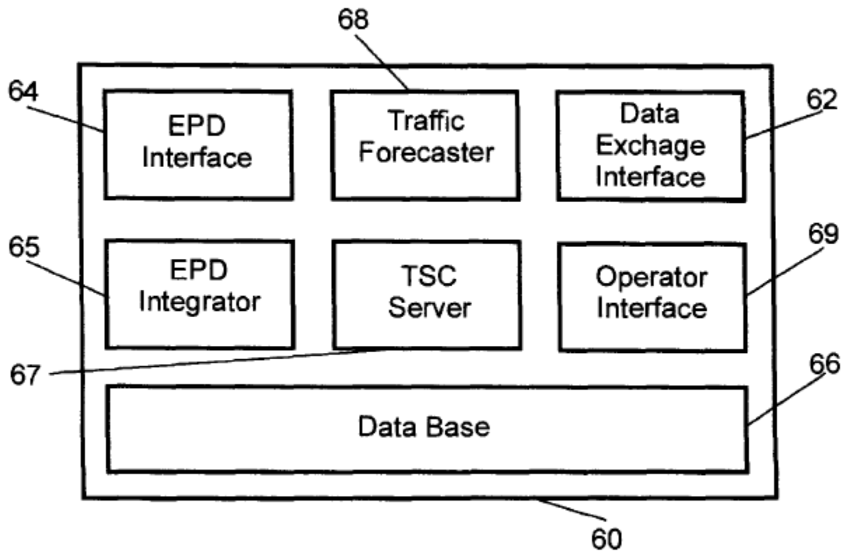


Figure 3

(*Id.*, Fig. 3.)

35. The digitized road network map provided by traffic service center 60 includes "nodes 14 and links 16 indicating a traffic direction. The node 14 may represent an intersection of two or more roads, an entry to a parking lot, a junction of a highway with an entry or exit ramp, a starting or an endpoint of a bridge, a tunnel, an overpass or an arbitrary location on a road. A link 16 represents a road segment with an orientation indication, which connects two nodes 14 of the road network." (*Id.*, 8:58-65.)

B. Overview of *Golding*

36. *Golding* discloses a "route planning and navigation system," an example of which is shown in Figure 1:

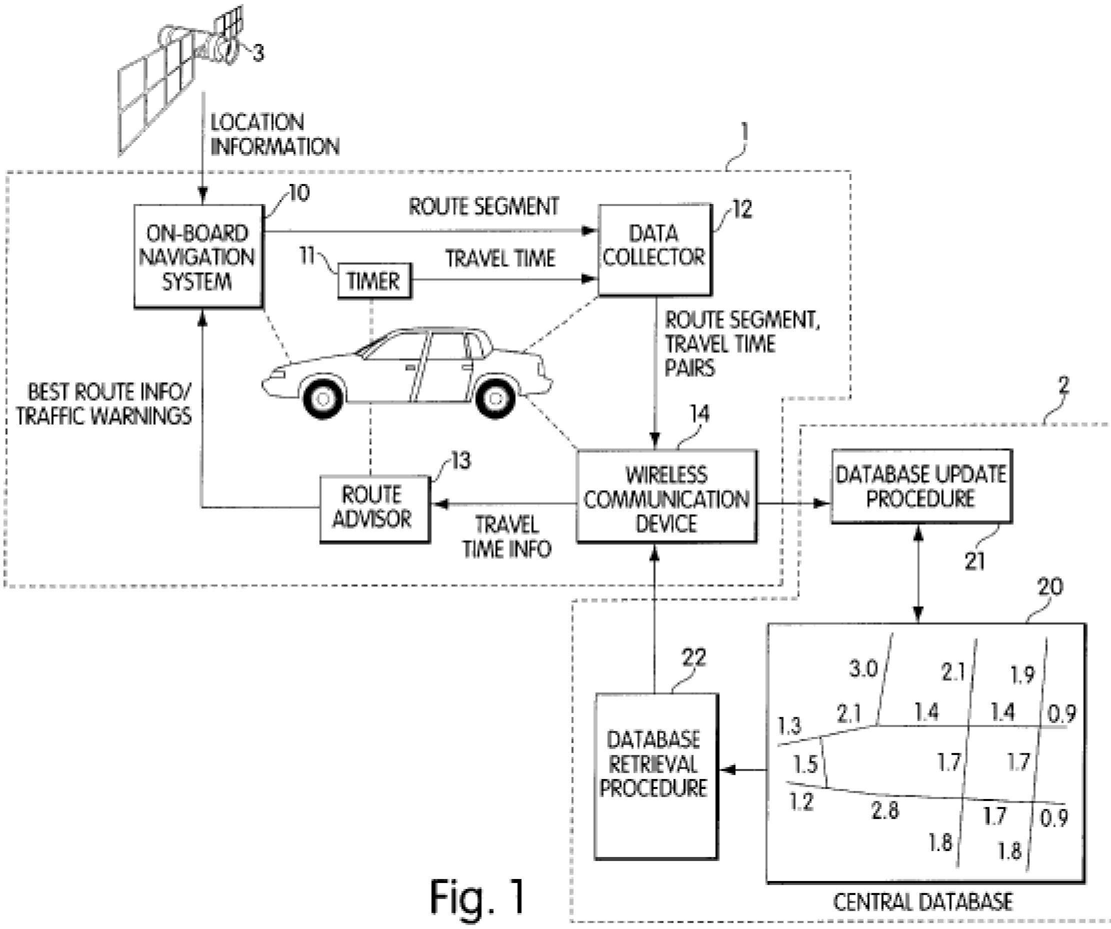


Fig. 1

(*Id.*, 4:31-33, Fig. 1.) The route planning and navigation system includes a vehicle navigation system 1, which is "located on each automobile within the system," and a central database 2. (*Id.*, 4:31-34.) *Golding* explains that data collector 12 of navigation system 1 collects travel time information for various street segments, which is transmitted by wireless communication device 14 to central database 2 for storage. (*Id.*, 3:33-37, 5:5-58.)

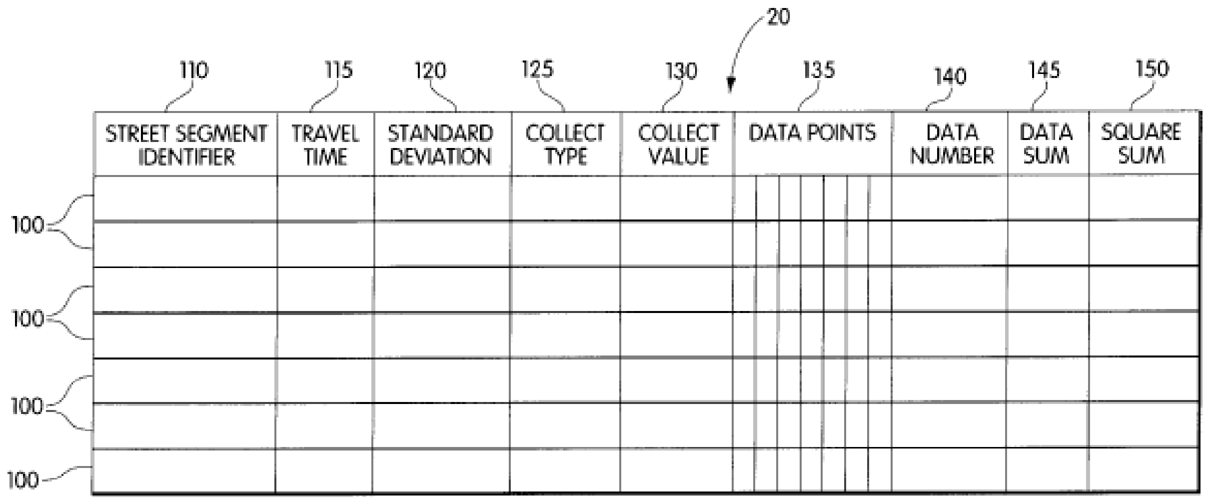


Fig. 2

(*Id.*, 4:26-27, 6:11-27, Fig. 2 (depicting an example of the data stored by central database 2).)

37. Route advisor 13 of vehicle navigation system 1 is configured to determine a "best route from a starting point to a destination location." (*Id.*, 4:49-50.) To do so, route advisor 13 uses travel time information available at central database 2 to determine a route having minimum travel time. (*See, e.g.*, *id.*, 3:29-31.) *Golding* explains, however, that "in order to limit the required memory, the route advisor [13] can have travel time information for only a portion of the map database in which the automobile is presently located. The route advisory could then obtain any additional travel time information from the central database, as needed." (*Id.*, 4:53-58.) For example, "[w]hen planning a route, the route advisor

13 can contact the central database 2 to obtain updated information for the locations of interest." (*Id.*, 6:32-34.)

C. Overview of *Trovato*

38. *Trovato* discloses a "travel direction speaking system." (Ex. 1005 at Abstract.) In *Trovato*, a "computer determines a route between an origin and a destination using an electronic map," along with "driving instructions" associated with turns that a driver will need to make. (*Id.*, 2:6-11.) A driving instruction is output when a GPS reading is within a specified range of the position associated with the driving instruction. (*Id.*, 2:11-16.) A driving instruction is output using a "text to voice unit that converts the text driving instructions into a voice signal." (*Id.*, 2:34-35.)

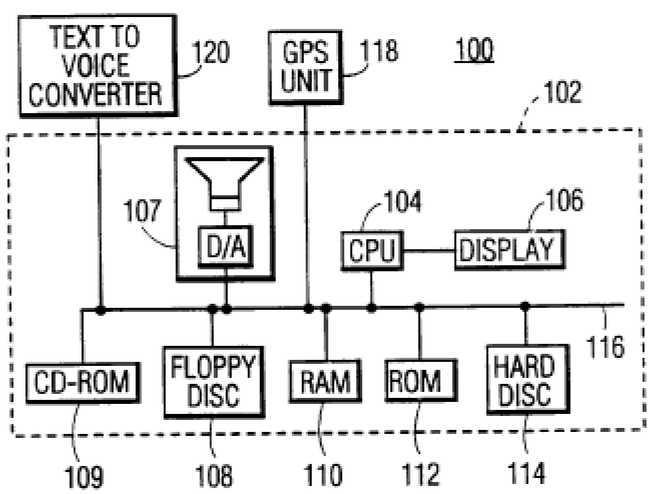


FIG. 1

(*Id.*, Fig. 1 (depicting the GPS unit 118 and text to voice converter 120).)

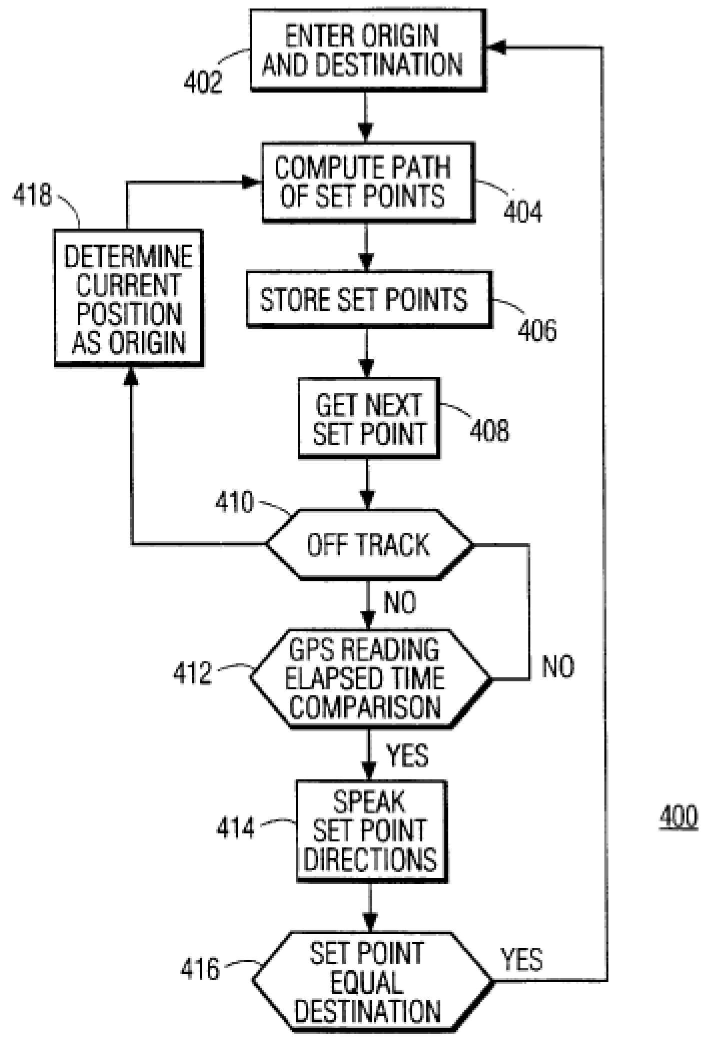


FIG. 4

(*Id.*, 5:64-67, Fig. 4 (depicting the process that is performed in determining which direction to issue and when to issue the direction).)

39. *Trovato* selects the "specified range" at which the driving instruction is output in a manner that can ensure "there is enough time to speak the directions

sufficiently in advance of the turn to allow the driver to make the turn." (*Id.*, 1:58-60; *see also id.*, 2:16-27.)

D. Claims 1-7, 9-15, 17-21, 23-28, and 30 of the '234 Patent

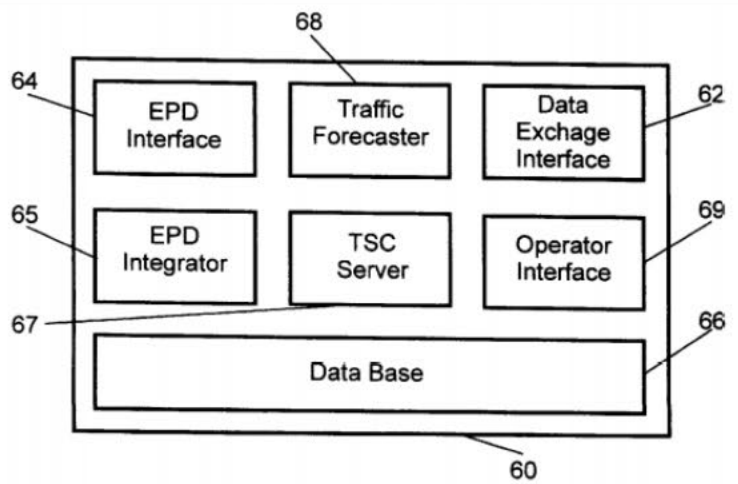
1. *Xu* Discloses the Features of Claims 1-7, 9-15, 17-21, 23-28, and 30

40. In my opinion, *Xu* discloses all of the features recited in claims 1-7, 9-15, 17-21, 23-28, and 30 of the '234 patent.

41. As described below, *Xu* discloses the features of claim 1:

Claim Language	*Xu*
1.a: A method for navigation using a navigation device which includes a location-sensing element therein, the method comprising:	*Xu* discloses a method for navigation using a navigation device (in-vehicle device 21) which includes a location-sensing element (locator 32 and GPS receiver 22). (*See* my analysis and citations above in VII.A.) For example, *Xu* discloses that in-vehicle device 21 has a "vehicle support sub-system 30," which "includes a road network locator 32 (hereinafter locator 32) and a road explorer 34." (Ex. 1004 at 7:21-23.) The in-vehicle device 21 also has a "computer system 26 for operating the sub-systems and storing the digitized road network map," as well as a "mobile radio sub-system 24 . . . for exchanging

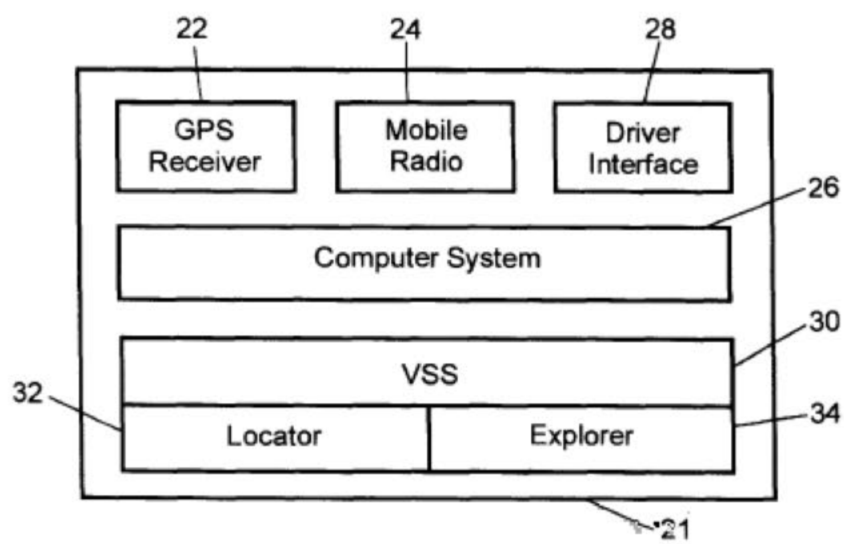
Claim Language	*Xu*
	radio frequency data with [a] traffic service center 60," and a "driver interface 28 . . . to permit drivers to interact with the in-vehicle device 21." (*Id.*, 7:23-31.) The "locator 32 computes the geographical location of the vehicle, using data received from [a] GPS receiver 22, and converts it to a position on the digitized road network map, which is broadcast from the traffic service center 60 via the communication station 50 and stored in the computer system 26." (*Id.*, 7:32-37; *see also id.*, Fig. 3 (depicting the traffic service center 60).)
1.b: forming a database storing traffic information for extraction thereof with respect to areas;	*Xu* discloses forming a database storing traffic information for extraction thereof with respect to areas. The traffic data remote collection and intelligent vehicle highway system in *Xu* includes a "traffic service center 60," as shown in Figure 3, which includes collections of data that disclose the claimed "database."

Claim Language	***Xu***
	 Figure 3 (Ex. 1004 at Fig. 3.) The traffic service center 60 includes "[a] data exchange interface 62 [] provided for connection of the communication station 50 for **receiving the vehicle position data** and sending data respecting the digitized road network maps and real-time traffic forecast data which are to be broadcast." (*Id.*, 8:19-23 (emphasis added).) In addition, "[a]n external party interface 64 is provided to connect the external party data sources 70 to **receive real-time information about weather or road conditions**. The real-time information is processed by an

Claim Language	*Xu*
	external party data integrator 65 for incorporation into **real-time traffic forecasts**." (*Id.*, 8:23-28 (emphasis added).) In other words, traffic service center 60 receives data relating to traffic information from both vehicles and external party data sources. Traffic service center 60 uses the received data to form collections of data relating to traffic information for extraction thereof with respect to areas. For example, *Xu* explains that "**traffic forecasts are computed by a traffic forecaster 68 using the collected vehicle position data** for normal road conditions. The collected vehicle position data received from the data exchange interface 62 is stored in a database 66 to be processed by the traffic forecaster 68." (*Id.*, 8:28-33 (emphasis added).) With respect to how traffic forecaster 68 computes the traffic forecasts, *Xu* explains that the "traffic forecaster 68 retrieves traffic data for two adjacent nodes from the database 66, and determines a time at which the vehicle was on the source

Claim Language	*Xu*
	node of the link and a time the vehicle was on the sink node of the link," wherein the "travel time of the vehicle for the link is determined by calculating a difference between the two times" and the "travel speed for the link is determined by dividing a length of the link by the travel time." (*Id.*, 11:50-57; *see also id.*, 11:57-60 ("The data including the travel time, or vehicle travel speed for each link are computed from time to time from each vehicle 20 to provide **a database for forecasting traffic conditions for the roadway system 10**.") (emphasis added).) In *Xu*, a "link" (e.g., with respect to the "links" discussed above) represents "a road segment with an orientation indication, which connects two nodes 14 of the road network," wherein a "node" (e.g., with respect to the "nodes" discussed above) may represent "an intersection of two or more roads, an entry to a parking lot, a junction of a highway with an entry or exit ramp, a starting or an endpoint of a bridge, a tunnel, an overpass or an arbitrary

Claim Language	*Xu*
	location on a road." (*Id.*, 8:58-65.) In other words, each "link" is associated with a respective area. (*Id.*; *see also id.*, 13:22-65 (explaining that the traffic information is received by in-vehicle device 21 and can be extracted with respect to block areas of the digitized road network map).) Therefore, traffic service center 60 is formed to store collections of data including traffic information for extraction thereof with respect to areas. (*See also* my analysis and citations above in VII.A.)
1.c: receiving data concerning a location of the navigation device which is determined using the location-sensing element;	*Xu* discloses receiving data concerning a location of the navigation device which is determined using the location-sensing element. For example, *Xu* discloses that "[e]ach vehicle 20 equipped with a GPS receiver [22] aligned to **receive global positioning information** from the constellation of satellites 42 uses the GPS positioning information **to determine a vehicle's geographical position**." (Ex. 1004 at 9:66-10:2 (emphasis added).) This determination can be

Claim Language	*Xu*
	made by locator 32, which "computes the geographical location of the vehicle, using data received from the GPS receiver 22, and converts it to a position on the digitized road network map." (*Id.*, 7:32-34.) In other words, vehicle 20's GPS receiver 22 receives global positioning information from GPS satellites 42, which is then used by locator 32 to determine vehicle 20's geographical location.  Figure 2 (*Id.*, Fig. 2 (depicting GPS receiver 22 and locator 32 as part of in-vehicle device 21).) (*See also* my analysis and citations above in VII.A.)

Claim Language	***Xu***
1.d: searching the database for traffic information specific to a coverage area including the location of the navigation device;	*Xu* discloses searching the database for traffic information specific to a coverage area including the location of the navigation device. For example, *Xu* explains that traffic service center 60 divides the digitized road network map 13 into smaller blocks (e.g., based on post code zones, or arbitrary street zones) and associates the traffic information of respective "links" with a "block number for identifying where each link is located." (*See* Ex. 1004 at 13:30-37.) The data is broadcast from the traffic service center 60 as a digitized road network map 13 and received by the in-vehicle device 21. (Ex. 1004 at 13:48-50.) *Xu* discloses that geographical blocks are flagged based on the location of the in-vehicle device 21 both before a request for planning a route is entered (*id*., 13:48-50, 13:66-14:4) and after a request for planning a route is entered (*id*., 13:26-58). For example, with respect to flagging that occurs before a request for planning a route is entered, *Xu* explains that "where the driver does not enter a destination

Claim Language	*Xu*
	for the trip, or where the driver has no clear, determined destination, the locator 32 uses a configurable radius, and a circle centered at the current vehicle's position is made with the given radius. Blocks within or partly within the circle are flagged." (*Id.*, 13:66-14:4.) Thus, even before a request for planning a route is entered, blocks are flagged that include the location of the vehicle. In-vehicle device 21 analyzes the received data, *Xu* explaining that "[t]he travel time forecast is received from the traffic service center and traffic data relating to the flagged blocks is stored by the computer system 26," with "[t]raffic forecast data not related to the flagged blocks [] discarded." (*Id.*, 13:58-62.) Therefore, in-vehicle device 21 searches the collections of data of traffic service center 60 ("the database") for traffic forecast data ("traffic information") specific to a geographical blocks including the geographic area that the in-vehicle device 21 is located in, which is a subset of the geographic area over which the navigation system operates ("a coverage area including the

Claim Language	***Xu***
	location of the navigation device"). (*See also* my analysis and citations above in VII.A.)
1.e: receiving a request for planning a route from an origination to a destination;	*Xu* discloses receiving a request for planning a route from an origination to a destination. For example, *Xu* discloses that "a destination for [a] trip may be entered by a driver using the driver interface 28." (Ex. 1004 at 13:53-55.) The "locator 32 executes a program to find a block chain that starts from the block where the vehicle is currently located," e.g., an origination, "and ends at a block in which the destination is located," e.g., a destination. (*Id.*, 13:55-58; *see also id.*, 13:62-65 (explaining that the driver can also change the route or destination).) Driver interface 28 "includes a microphone, data entry pad, screen display and loud-speaker to permit drivers to interact with the in-vehicle device 21." (*Id.*, 7:28-31.) The system in *Xu* uses the "driver's instructions received from the driver interface 28 to provide intelligent route

Claim Language	***Xu***
	guidance." (*Id.*, 7:49-50.) (*See also* my analysis and citations above in VII.A.)
1.f: determining that the coverage area is different from one or more areas in navigation coverage defined at least by the origination and the destination;	*Xu* discloses determining that the coverage area is different from one or more areas in navigation coverage defined at least by the origination and the destination. For example, *Xu* discloses that "[t]he locator 32 executes a program to find a block chain that starts from the block where the vehicle is currently located, and ends at a block in which the destination is located. These chained blocks are flagged." (Ex. 1004 at 13:55-58.) Moreover, *Xu* also discloses that "[i]f the route or destination is changed by the driver, the chained block list is re-computed and traffic forecast information for any newly flagged blocks is screened from a traffic forecast at the next [Traffic Broadcasting Interval]." (*Id.*, 13:62-65.) Therefore, when a route is being planned, *Xu* determines whether the initially flagged geographical blocks that included the in-vehicle device 21's current location (i.e., the "coverage area") are

Claim Language	***Xu***
	different from newly flagged blocks formed from a new route or changed destination. In other words, the block flagging process determines geographic areas associated with the route between the origination and the destination that are different than the geographic area previously determined to be associated with the location of the in-vehicle device 21. One of ordinary skill in the art would have understood that in *Xu*, data relating to the initially flagged blocks (flagged, for example, before a route request was received, or before a route request was updated) are received from traffic service center 60. Then, when new blocks are flagged based on a new route or changed destination, that flagging of the new blocks would represent a determination that the initially flagged geographical blocks that included the in-vehicle device 21's current location (i.e., "coverage area") are different from the one or more areas represented by the newly flagged blocks (i.e., in the "navigation coverage").

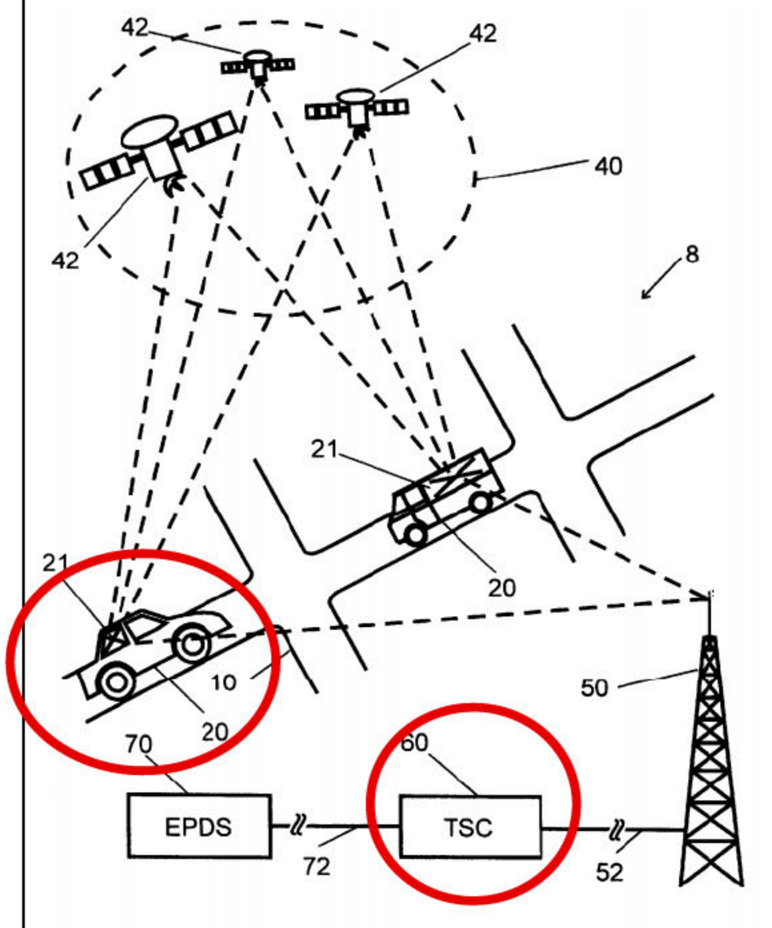
Claim Language	***Xu***
	(*See also* my analysis and citations above in VII.A.)
1.g: searching the database for selected traffic information specific to the one or more areas; and	*Xu* discloses searching the database for selected traffic information specific to the one or more areas. For example, *Xu* explains that traffic service center 60 divides the digitized road network map 13 into smaller blocks (e.g., based on post code zones, or arbitrary street zones) and associates the traffic information of respective "links" with a "block number for identifying where each link is located." (*See* Ex. 1004 at 13:30-37.) The data is broadcast from the traffic service center 60 as a digitized road network map 13 and received by the in-vehicle device 21. (*Id.*, 13:48-50.) *Xu* discloses that geographical blocks are flagged based on the location of the in-vehicle device 21 both before a request for planning a route is entered (*see id.*, 13:66-14:4) and ***after*** a request for planning a route is entered (*see id.*, 13:26-58). In-vehicle device 21 analyzes the received data, explaining that "[t]he travel time forecast is received from the traffic

Claim Language	*Xu*
	service center and traffic data relating to the flagged blocks is stored by the computer system 26. Traffic forecast data not related to the flagged blocks is discarded." (*Id.*, 13:58-62; *see also id.*, 11:43-53 ("the traffic service center 60 uses a simple calculation to compute the travel time of a vehicle for a specific link or the vehicle travel speed on the link. The traffic forecaster 68 retrieves traffic data for two adjacent nodes from the database 66, and determines a time at which the vehicle was on the source node of the link and a time the vehicle was on the sink node of the link").) This analysis occurs after the blocks are flagged, since the analysis is fundamentally based on which blocks are flagged. In other words, since "traffic forecast data not related to the flagged blocks is discarded," only after the blocks are flagged will the traffic forecast data related to the newly flagged blocks actually be related to the flagged blocks. Therefore, in-vehicle device 21 searches collections of

Claim Language	***Xu***
	data of traffic service center 60 ("the database") for traffic forecast data ("selected traffic information") specific to the flagged blocks. (*See also* my analysis and citations above in VII.A.)
1.h: planning a route to the destination, taking into consideration at least traffic conditions derived from the selected traffic information.	*Xu* discloses planning a route to the destination, taking into consideration at least traffic conditions derived from the selected traffic information. For example, *Xu* discloses that "[t]he data received by the mobile radio sub-system 24 is stored by the computer system 26 and the road network explorer 34 uses the data in conjunction with driver's instructions received from the driver interface 28 to provide intelligent route guidance. The intelligent route guidance, such as an optimum travel route based on **real-time traffic conditions**, is displayed on the screen display (not shown) of the driver interface 28." (Ex. 1004 at 7:46-53 (emphasis added).) *Xu* also discloses that "[t]he in-vehicle device 21 on each vehicle 20 receives the traffic conditions from traffic

Claim Language	*Xu*
	service center 60 and processes information included in the traffic condition broadcasts to provide route planning to the driver by recommending real-time optimum travel routes based on real-time or forecast traffic conditions." (*Id*., 7:55-60.) *Xu* further discloses that after a "destination for the trip [is] entered by a driver using the driver interface 28," the "locator 32 executes a program to find a block chain that **starts from the block where the vehicle is currently located, and ends at a block in which the destination is located**." (*Id*., 13:50-58 (emphasis added).) (*See also* my analysis and citations above in VII.A.)

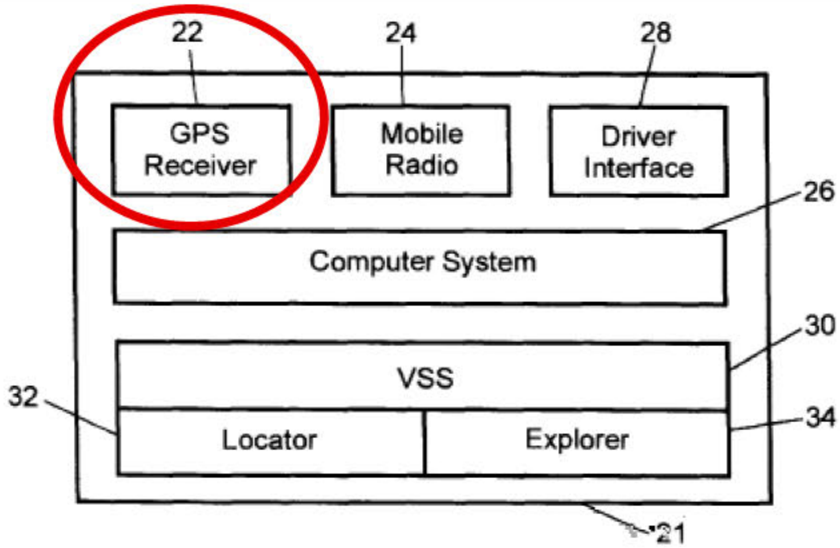
42. As described below, *Xu* also discloses the features of claim 2:

Claim Language	***Xu***
2. The method of claim 1 wherein the database is external to the navigation device.	*Xu* discloses that the database is external to the navigation device. For example, as shown in Figure 1, traffic service center 60 is external to in-vehicle device 21.  Figure 1 (Ex. 1004 at Fig. 1 (annotated).) Figure 1 illustrates a

Claim Language	***Xu***
	scenario in which in-vehicle device 21 and traffic service center 60 communicate via wireless communication, thus allowing for traffic service center 60 to be external to in-vehicle device 21. *Xu* explains that the "in-vehicle device 21 transmits the static road positions of the vehicle as radio frequency data to a communication station 50 and the communication station 50 in turn transfers the static vehicle positions through a transfer medium 52 to [the] traffic service center 60." (*Id.*, 6:39-44; *see also id.*, 8:17-36 (describing the configuration of the traffic service center 60).) Thus, the data in traffic service center 60 that corresponds to the claimed "database" is external to in-vehicle device 21. (*See also* my analysis and citations above in VII.A.)

43. As described below, *Xu* discloses the features of claim 3:

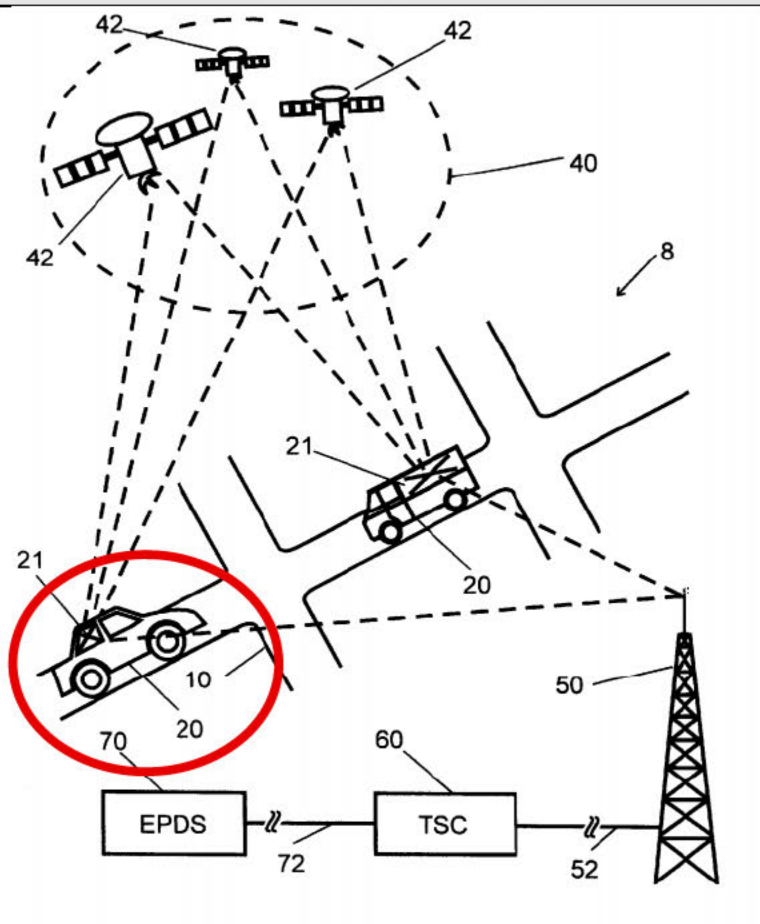
Claim Language	***Xu***
3. The method of claim 1 wherein the location of the navigation device is defined by GPS coordinates.	*Xu* discloses that the location of the navigation device is defined by GPS coordinates. For example, *Xu* discloses that "[t]he locator 32 computes the geographical location of the vehicle, using data received from the GPS receiver 22." (Ex. 1004 at 7:32-33; *see also id.*, 7:4-9 ("The GPS satellites 42 transmit global positioning information to the GPS receivers 22 installed in the vehicles 20. Each receiver 22 interprets the signals from three or more satellites 42 and determines a geographical position with an accuracy within an average of 20 meters.").) The location of vehicle 20, which is defined by the GPS coordinates provided by GPS receiver 22, reflects the location of in-vehicle device 21 since in-vehicle device 21 is within vehicle 20.

Claim Language	*Xu*
	 Figure 2 (*Id.*, Fig. 2.) (*See also* my analysis and citations above in VII.A.)

44. As described below, *Xu* discloses the features of claim 4:

Claim Language	*Xu*
4. The method of claim 1 wherein the navigation device is used in a vehicle.	*Xu* discloses that the navigation device is used in a vehicle. For example, *Xu* discloses that "[e]ach vehicle 20 is equipped with an in-vehicle device 21." (Ex. 1004 at 6:30-31.) *Xu* further discloses that "vehicle support

Claim Language	*Xu*
	sub-system 30 is provided in the in-vehicle device 21," which "includes a road network locator 32 (hereinafter locator 32) and a road explorer 34." (*Id.*, 7:21-23.) "A mobile radio sub-system 24 is provided for exchanging radio frequency data with the traffic service center 60 via the communication station 50. Also included in the in-vehicle device 21 are a computer system 26 for operating the sub-systems and storing the digitized road network map. A driver interface 28 includes a microphone, data entry pad, screen display and loud-speaker to permit drivers to interact with the in-vehicle device 21." (*Id.*, 7:23-31.) Thus, as the name of in-vehicle device 21 makes clear, *Xu* explains that in-vehicle device 21 is used in vehicle 20.

Claim Language	*Xu*
	 Figure 1 (*Id.*, Fig. 1.) (*See also* my analysis and citations above in VII.A.)

45. As described below, *Xu* discloses the features of claim 5:

Claim Language	*Xu*
5. The method of claim 1	*Xu* discloses that road conditions are also taken into

Claim Language	***Xu***
wherein road conditions are also taken into consideration in planning the route.	consideration in planning the route. For example, *Xu* discloses that, prior to broadcasting travel time forecasts, the traffic service center 60 may weight "[r]eal-time abnormal traffic conditions . . . in a plurality of ways." (Ex. 1004 at 12:54-55.) For example, a "closed road segment, for example, may be assigned a weight factor of 1000, the weight factor being used to calculate a predicted link travel time. Therefore, a subsequent broadcast will show that link travel time is 1000 times greater than a normal travel time and the road explorers 34 or drivers will realize the link is impossible." (*Id.*, 12:55-61.) As another example, a "weight factor of 5 . . . may be used to adjust a travel time for links which are in regions experiencing heavy snow." (*Id.*, 12:61-63.) A "database is preferably established for storing weighting factors associated with abnormal traffic and inclement weather conditions." (*Id.*, 12:63-65.)

Claim Language	*Xu*
	In addition, the "current traffic conditions may also affect traffic forecasts, such that "[i]f there is congestion on a link which is not normally congested and the congestion is completely due to traffic volume, the traffic service center receives a plurality of traffic data indicating that the link is experiencing an unusual congestion, by comparing the current traffic status with the normal traffic condition. This unusual congestion is also used to adjust the next traffic forecast." (*Id.*, 12:66-13:6.) *Xu* explains that the "in-vehicle device 21 on each vehicle 20 receives the traffic conditions from traffic service center 60 and processes information included in the traffic condition broadcasts to provide route planning to the driver by recommending real-time optimum travel routes based on real-time or forecast traffic conditions." (*Id.*, 6:55-60.) In other words, in *Xu*, the data at traffic service center

Claim Language	*Xu*
	60 is based on road conditions. This road-condition-based data is then sent to in-vehicle device 21 and used to plan a route. Thus, road conditions are taken into consideration when in-vehicle device 21 plans a route. (*See also* my analysis and citations above in VII.A.)

46. As described below, *Xu* discloses the features of claim 6:

Claim Language	*Xu*
6. The method of claim 1 wherein weather conditions are also taken into consideration in planning the route.	*Xu* discloses that weather conditions are also taken into consideration in planning the route. For example, *Xu* discloses that, prior to broadcasting travel time forecasts, the traffic service center 60 may weight "[r]eal-time abnormal traffic conditions . . . in a plurality of ways." (Ex. 1004 at 12:54-55.) For example, a "weight factor of 5 . . . may be used to adjust a travel time for links which are in regions experiencing **heavy snow**." (*Id.*, 12:61-63 (emphasis added).) A "database is preferably established for

Claim Language	*Xu*
	storing weighting factors associated with . . . **inclement weather conditions**." (*Id.*, 12:63-65 (emphasis added).) *Xu* explains that the "in-vehicle device 21 on each vehicle 20 receives the traffic conditions from traffic service center 60 and processes information included in the traffic condition broadcasts to provide route planning to the driver by recommending real-time optimum travel routes based on real-time or forecast traffic conditions." (*Id.*, 6:55-60.) In other words, in *Xu*, the data at traffic service center 60 is based on weather conditions. This weather-condition-based data is then sent to in-vehicle device 21 and used to plan a route. Thus, weather conditions, such as heavy snow, are taken into consideration when in-vehicle device 21 plans a route. (*See also* my analysis and citations above in VII.A.)

47. As described below, *Xu* discloses the features of claim 7:

Claim Language	***Xu***
7. The method of claim 1 wherein the navigation device includes a display element, and at least part of the planned route is shown on the display element.	*Xu* discloses that the navigation device includes a display element, and at least part of the planned route is shown on the display element. For example, *Xu* discloses that "[t]he data received by the mobile radio sub-system 24 is stored by the computer system 26 and the road network explorer 34 uses the data in conjunction with driver's instructions received from the driver interface 28 to provide intelligent route guidance. The intelligent route guidance, such as an optimum travel route based on real-time traffic conditions, is displayed on the screen display (not shown) of the driver interface 28." (Ex. 1004 at 7:46-53.) In other words, *Xu* explains that the driver interface 28 of in-vehicle device 21 includes a screen display, and that the "optimum travel route" is displayed on the screen display of driver interface 28. (*See also* my analysis and citations above in VII.A.)

48. As described below, *Xu* discloses the features of claim 9:

Claim Language	***Xu***
9.a: A method for navigation using a navigation device which includes a location-sensing element therein, the method comprising:	*Xu* discloses a method for navigation using a navigation device (in-vehicle device 21) which includes a location-sensing element (locator 32 and GPS receiver 22). (*See* my analysis and citations above for claim element 1.a (preamble); my analysis and citations above in VII.A.)
9.b: forming a database storing weather information for extraction thereof with respect to areas;	*Xu* discloses forming a database storing weather information for extraction thereof with respect to areas, for at least the same reasons discussed above for claim element 1.b and claim 6. (*See* my analysis and citations above in ¶¶ 41 and 46.) With respect to "weather information," *Xu* specifically explains that an "external party interface 64 is provided to connect the external party data sources 70 to **receive real-time information about weather** or road **conditions**. The real-time information is processed by an external party data integrator 65 for incorporation into **real-time traffic forecasts**." (Ex.

Claim Language	***Xu***
	1004 at 8:23-28 (emphasis added).) Moreover, *Xu* also explains that the traffic service center 60 may weight "[r]eal-time abnormal traffic conditions . . . in a plurality of ways." (*Id.*, 12:54-55.) For example, a "weight factor of 5 . . . may be used to adjust a travel time for links which are in **regions experiencing heavy snow**." (*Id.*, 12:61-63 (emphasis added).) A "database is preferably established [by traffic service center 60] for storing weighting factors associated with . . . inclement weather conditions." (*Id.*, 12:63-65.) Therefore, for these reasons, in addition to the reasons discussed above with respect to claim element 1.b and claim 6, traffic service center 60 is formed to store weather information, such as information relating to snow conditions, for extraction thereof with respect to areas. In other words, the "database" that I discuss above for claim element 1.b with respect to storing traffic information also stores weather information. (*See also* my analysis and citations above in VII.A.)

Claim Language	***Xu***
9.c: receiving data concerning a location of the navigation device which is determined using the location-sensing element;	*Xu* discloses receiving data concerning a location of the navigation device which is determined using the location-sensing element, for at least the same reasons discussed above for claim element 1.c. (*See* my analysis and citations above in ¶ 41.) (*See also* my analysis and citations above in VII.A.)
9.d: searching the database for weather information specific to a coverage area including the location of the navigation device;	*Xu* discloses searching the database for weather information specific to a coverage area including the location of the navigation device, for at least the same reasons discussed above for claim element 1.d. (*See* my analysis and citations above in ¶ 41.) In particular, for similar reasons I discussed above for claim element 9.b, the traffic information discussed above for claim element 1.d includes weather information. (*See also* my analysis and citations above in VII.A.)
9.e: receiving a request for planning a route from an origination to a	*Xu* discloses receiving a request for planning a route from an origination to a destination, for at least the same reasons discussed above for claim element 1.e.

Claim Language	***Xu***
destination;	(*See* my analysis and citations above in ¶ 41.) (*See also* my analysis and citations above in VII.A.)
9.f: determining that the coverage area is different from one or more areas in navigation coverage defined at least by the origination and the destination;	*Xu* discloses determining that the coverage area is different from one or more areas in navigation coverage defined at least by the origination and the destination, for at least the same reasons discussed above for claim element 1.f. (*See* my analysis and citations above in ¶ 41.) (*See also* my analysis and citations above in VII.A.)
9.g: searching the database for selected weather information specific to the one or more areas; and	*Xu* discloses searching the database for selected weather information specific to the one or more areas, for at least the same reasons discussed above for claim element 1.g. (*See* my analysis and citations above in ¶ 41.) (*See also* my analysis and citations above in VII.A.)
9.h: planning a route to the destination, taking into consideration at least weather conditions	*Xu* discloses planning a route to the destination, taking into consideration at least weather conditions derived from the selected weather information, for at least the same reasons discussed above for claim element 1.h.

Claim Language	*Xu*
derived from the selected weather information.	(*See* my analysis and citations above in ¶ 41.) In particular, as discussed for claim element 9.b, the traffic information discussed above for claim element 1.g includes weather information. (*See also* my analysis and citations above in VII.A.)

49. As described below, *Xu* discloses the features of claim 10:

Claim Language	*Xu*
10. The method of claim 9 wherein the database is external to the navigation device.	*Xu* discloses that the database is external to the navigation device, for at least the same reasons discussed above for claim 2. (*See* my analysis and citations above in ¶ 42.) (*See also* my analysis and citations above in VII.A.)

50. As described below, *Xu* discloses the features of claim 11:

Claim Language	*Xu*
11. The method of claim 9 wherein the location of	*Xu* discloses that the location of the navigation device is defined by GPS coordinates, for at least the same

Claim Language	*Xu*
the navigation device is defined by GPS coordinates.	reasons discussed above for claim 3. (*See* my analysis and citations above in ¶ 43.) (*See also* my analysis and citations above in VII.A.)

51. As described below, *Xu* discloses the features of claim 12:

Claim Language	*Xu*
12. The method of claim 9 wherein the navigation device is used in a vehicle.	*Xu* discloses that the navigation device is used in a vehicle, for at least the same reasons discussed above for claim 4. (*See* my analysis and citations above in ¶ 44.) (*See also* my analysis and citations above in VII.A.)

52. As described below, *Xu* discloses the features of claim 13:

Claim Language	*Xu*
13. The method of claim 9 wherein road conditions are also taken into consideration in	*Xu* discloses that road conditions are also taken into consideration in planning the route, for at least the same reasons discussed above for claim 5. (*See* my analysis and citations above in ¶ 45.) (*See also* my

Claim Language	*Xu*
planning the route.	analysis and citations above in VII.A.)

53. As described below, *Xu* discloses the features of claim 14:

Claim Language	*Xu*
14. The method of claim 9 wherein traffic conditions are also taken into consideration in planning the route.	*Xu* discloses that traffic conditions are also taken into consideration in planning the route, for at least the same reasons discussed above for claim 5. (*See* my analysis and citations above in ¶ 45.) In particular, as discussed, the road conditions in *Xu* include traffic conditions. (*See also* my analysis and citations above in VII.A.)

54. As described below, *Xu* discloses the features of claim 15:

Claim Language	*Xu*
15. The method of claim 9 wherein the navigation device includes a display element, and at least part	*Xu* discloses that the navigation device includes a display element, and at least part of the planned route is shown on the display element, for at least the same reasons discussed above for claim 7. (*See* my analysis

Claim Language	*Xu*
of the planned route is shown on the display element.	and citations above in ¶ 47.) (*See also* my analysis and citations above in VII.A.)

55. As described below, *Xu* discloses the features of claim 17:

Claim Language	*Xu*
17.a: A navigation system for a user traveling in a vehicle, comprising:	*Xu* discloses a navigation system (e.g., a traffic data remote collection and intelligent vehicle highway system) for a user traveling in a vehicle (e.g., vehicle 20). (*See* my analysis and citations above in VII.A.)
17.b: a database formed to store traffic information for extraction thereof with respect to areas;	*Xu* discloses a database formed to store traffic information for extraction thereof with respect to areas, for at least the same reasons discussed above for claim element 1.b. (*See* my analysis and citations above in ¶ 41.) (*See also* my analysis and citations above in VII.A.)
17.c: a processing unit for searching the database for traffic	*Xu* discloses a processing unit for searching the database for traffic information specific to a coverage area including the location of the vehicle, for at least

Claim Language	***Xu***
information specific to a coverage area including the location of the vehicle; and	the same reasons discussed above for claim element 1.c-d. (*See* my analysis and citations above in ¶ 41.) In particular, *Xu* discloses that the in-vehicle device 21 includes "a computer system 26 for operating the sub-systems and storing the digitized road network map," and thus the computer system 26 would perform the claimed "searching," as discussed above for claim element 1.d. (*See* Ex. 1004 at 7:26-28.) One of ordinary skill in the art would have thus understood that the computer system 26 is a "processing unit" for searching the database as recited in this claim element. (*See also* my analysis and citations above in VII.A.)
17.d: an interface for receiving a request for planning a route from an origination to a destination,	*Xu* discloses an interface for receiving a request for planning a route from an origination to a destination, for at least the same reasons discussed above for claim element 1.e. (*See* my analysis and citations above in ¶ 41.) In particular, *Xu* discloses that "a destination for [a] trip may be entered by a driver using the driver interface 28." (Ex. 1004 at 13:53-55.) The "locator 32

Claim Language	*Xu*
	executes a program to find a block chain that starts from the block where the vehicle is currently located," e.g., an origination, "and ends at a block in which the destination is located," e.g., a destination. (*Id.*, 13:55-58; *see also id.*, 13:62-65 (explaining that the driver can also change the route or destination).) Driver interface 28 "includes a microphone, data entry pad, screen display and loud-speaker to permit drivers to interact with the in-vehicle device 21." (*Id.*, 7:28-31.) The system in *Xu* uses the "driver's instructions received from the driver interface 28 to provide intelligent route guidance." (*Id.*, 7:49-50.) (*See also* my analysis and citations above in VII.A.)
17.e: wherein when it is determined that the coverage area is different from one or more areas in navigation coverage defined at least	*Xu* discloses that, when it is determined that the coverage area is different from one or more areas in navigation coverage defined at least by the origination and the destination, the processing unit searches the database for selected traffic information specific to the one or more areas, for at least the same reasons

Claim Language	***Xu***
by the origination and the destination, the processing unit searches the database for selected traffic information specific to the one or more areas, and	discussed above for claim element 1.f-g. (*See* my analysis and citations above in ¶ 41.) In particular, *Xu* discloses that the in-vehicle device 21 includes "a computer system 26 for operating the sub-systems and storing the digitized road network map," and thus the computer system 26 performs the claimed "searching," as discussed above for claim element 1.g. (*See* Ex. 1004 at 7:26-28.) (*See also* my analysis and citations above in VII.A.)
17.f: wherein a route to the destination is planned, taking into consideration at least traffic conditions derived from the selected traffic information.	*Xu* discloses that a route to the destination is planned, taking into consideration at least traffic conditions derived from the selected traffic information, for at least the same reasons discussed above for claim element 1.h. (*See* my analysis and citations above in ¶ 41.) (*See also* my analysis and citations above in VII.A.)

56. As described below, *Xu* discloses the features of claim 18:

Claim Language	***Xu***
18. The system of claim 17 wherein the location of the vehicle is defined by GPS coordinates.	*Xu* discloses that the location of the vehicle is defined by GPS coordinates, for at least the same reasons discussed above for claim 3. (*See* my analysis and citations above in ¶ 43.) (*See also* my analysis and citations above in VII.A.)

57. As described below, *Xu* discloses the features of claim 19:

Claim Language	***Xu***
19. The system of claim 17 wherein road conditions are also taken into consideration in planning the route.	*Xu* discloses that road conditions are also taken into consideration in planning the route, for at least the same reasons discussed above for claim 5. (*See* my analysis and citations above in ¶ 45.) (*See also* my analysis and citations above in VII.A.)

58. As described below, *Xu* discloses the features of claim 20:

Claim Language	***Xu***
20. The system of claim	*Xu* discloses that weather conditions are also taken into

Claim Language	*Xu*
17 wherein weather conditions are also taken into consideration in planning the route.	consideration in planning the route, for at least the same reasons discussed above for claim 6. (*See* my analysis and citations above in ¶ 46.) (*See also* my analysis and citations above in VII.A.)

59. As described below, *Xu* discloses the features of claim 21:

Claim Language	*Xu*
21. The system of claim 17 wherein at least part of the planned route is shown on a display.	*Xu* discloses at least part of the planned route is shown on a display, for at least the same reasons discussed above for claim 7. (*See* my analysis and citations above in ¶ 47.) (*See also* my analysis and citations above in VII.A.)

60. As described below, *Xu* discloses the features of claim 23:

Claim Language	*Xu*
23. The system of claim 17 wherein the database is external to the vehicle.	*Xu* discloses that the database is external to the vehicle, for at least the same reasons discussed above for claim 2. (*See* my analysis and citations above in ¶

Claim Language	*Xu*
	42.) (*See also* my analysis and citations above in VII.A.)

61. As described below, *Xu* discloses the features of claim 24:

Claim Language	*Xu*
24.a: A navigation system for a user traveling in a vehicle, comprising:	*Xu* discloses a navigation system (e.g., a traffic data remote collection and intelligent vehicle highway system) for a user traveling in a vehicle (e.g., vehicle 20). (*See* my analysis and citations above in VII.A.)
24.b: a database formed to store weather information for extraction thereof with respect to areas;	*Xu* discloses a database formed to store weather information for extraction thereof with respect to areas, for at least the same reasons discussed above for claim element 17.b and claim 20. (*See* my analysis and citations above in ¶¶ 55 and 58.) With respect to "weather information," *Xu* specifically explains that an "external party interface 64 is provided to connect the external party data sources 70 to **receive real-time information about weather** or road **conditions**. The real-time information is processed by an external party

Claim Language	*Xu*
	data integrator 65 for incorporation into **real-time traffic forecasts**." (Ex. 1004 at 8:23-28 (emphasis added).) Moreover, *Xu* also explains that the traffic service center 60 may weight "[r]eal-time abnormal traffic conditions . . . in a plurality of ways." (*Id.*, 12:54-55.) For example, a "weight factor of 5 . . . may be used to adjust a travel time for links which are in regions experiencing heavy snow." (*Id.*, 12:61-63.) A "database is preferably established for storing weighting factors associated with . . . inclement weather conditions." (*Id.*, 12:63-65.) Therefore, for these reasons, in addition to the reasons discussed above with respect to claim element 17.b and claim 20, traffic service center 60 is formed to store weather information, such as information relating to snow conditions, for extraction thereof with respect to areas. In other words, the "database" that I discuss above for claim element 17.b with respect to storing traffic information also stores weather information.

Claim Language	*Xu*
	(*See also* my analysis and citations above in VII.A.)
24.c: a processing unit for searching the database for weather information specific to a coverage area including the location of the vehicle; and	*Xu* discloses a processing unit for searching the database for weather information specific to a coverage area including the location of the vehicle, for at least the same reasons discussed above for claim element 17.c. (*See* my analysis and citations above in ¶ 55.) In particular, as discussed for claim element 24.b, the traffic information discussed above for claim element 17.c includes weather information. (*See also* my analysis and citations above in VII.A.)
24.d: an interface for receiving a request for planning a route from an origination to a destination,	*Xu* discloses an interface for receiving a request for planning a route from an origination to a destination, for at least the same reasons discussed above for claim element 17.d. (*See* my analysis and citations above in ¶ 55.) (*See also* my analysis and citations above in VII.A.)
24.e: wherein when it is determined that the coverage area is	*Xu* discloses that, when it is determined that the coverage area is different from one or more areas in navigation coverage defined at least by the origination

Claim Language	***Xu***
different from one or more areas in navigation coverage defined at least by the origination and the destination, the processing unit searches the database for selected weather information specific to the one or more areas, and	and the destination, the processing unit searches the database for selected weather information specific to the one or more areas for at least the same reasons discussed above for claim element 17.e. (*See* my analysis and citations above in ¶ 55.) In particular, as discussed for claim element 24.b, the traffic information discussed above for claim element 17.e includes weather information. (*See also* my analysis and citations above in VII.A.)
24.f: wherein a route to the destination is planned, taking into consideration at least traffic conditions derived from the selected weather information.	*Xu* discloses that a route to the destination is planned, taking into consideration at least traffic conditions derived from the selected weather information, for at least the same reasons discussed above for claim element 17.f. (*See* my analysis and citations above in ¶ 55.) (*See also* my analysis and citations above in VII.A.)

62. As described below, *Xu* discloses the features of claim 25:

Claim Language	***Xu***
25. The system of claim 24 wherein the location of the vehicle is defined by GPS coordinates.	*Xu* discloses that the location of the vehicle is defined by GPS coordinates, for at least the same reasons discussed above for claim 18. (*See* my analysis and citations above in ¶ 56.) (*See also* my analysis and citations above in VII.A.)

63. As described below, *Xu* discloses the features of claim 26:

Claim Language	***Xu***
26. The system of claim 24 wherein road conditions are also taken into consideration in planning the route.	*Xu* discloses that road conditions are also taken into consideration in planning the route, for at least the same reasons discussed above for claim 19. (*See* my analysis and citations above in ¶ 57.) (*See also* my analysis and citations above in VII.A.)

64. As described below, *Xu* discloses the features of claim 27:

Claim Language	***Xu***
27. The system of claim	*Xu* discloses that traffic conditions are also taken into

Claim Language	*Xu*
24 wherein traffic conditions are also taken into consideration in planning the route.	consideration in planning the route, for at least the same reasons discussed above for claim 19. (*See* my analysis and citations above in ¶ 57.) (*See also* my analysis and citations above in VII.A.)

65. As described below, *Xu* discloses the features of claim 28:

Claim Language	*Xu*
28. The system of claim 24 wherein at least part of the planned route is shown on a display.	*Xu* discloses at least part of the planned route is shown on a display, for at least the same reasons discussed above for claim 21. (*See* my analysis and citations above in ¶ 59.) (*See also* my analysis and citations above in VII.A.)

66. As described below, *Xu* discloses the features of claim 30:

Claim Language	*Xu*
30. The system of claim 24 wherein the database is external to the vehicle.	*Xu* discloses that the database is external to the vehicle, for at least the same reasons discussed above for claim 23. (*See* my analysis and citations above in ¶

Claim Language	*Xu*
	60.) (*See also* my analysis and citations above in VII.A.)

2. The Combination of *Xu* and *Golding* Discloses the Features of Claims 1-7, 9-15, 17-21, 23-28, and 30

67. As discussed above, *Xu* discloses all of the limitations of claims 1-7, 9-15, 17-21, 23-28, and 30. However, I have been asked to consider a scenario where *Xu* does not disclose "searching the database for [traffic information or weather information] specific to a coverage area including the location of the navigation device," "determining that the coverage area is different from one or more areas in navigation coverage defined at least by the origination and the destination," and "searching the database for selected traffic information specific to the one or more areas," as recited in independent claims 1 and 9, or similarly recited in independent claims 17 and 24. In particular, I have been asked to interpret the claims under the assumption that the "searching the database" limitations must be performed at the database (whereas *Xu* performs such operations at the client) and/or that the flagged geographical blocks including the location of in-vehicle device 21 in *Xu* do not correspond to a "coverage area," as claimed.

68. In my opinion, based on the above narrower understanding of the claims, the combination of *Xu* and *Golding* discloses all of the features recited in claims 1-7, 9-15, 17-21, 23-28, and 30 of the ’234 patent.

69. *Golding* is directed to a “system located in an automobile [that] provides personalized traffic information and route planning capabilities.” (Ex. 1006 at Abstract.) *Golding* discloses that a “central database [2] would collect and store travel time information for the various street segments [and] when updated, the travel time information can be transferred from [the] central database to the individual automobiles.” (*Id.*, 3:33-37.) *Golding* also discloses that a “best route from a starting point to a destination location can be determined by [a] route advisor 13.” (*Id.*, 4:49-50.) For example, “a route planning system [can] use[] the travel time information to determine a route having minimum travel time.” (*Id.*, 3:29-31.)

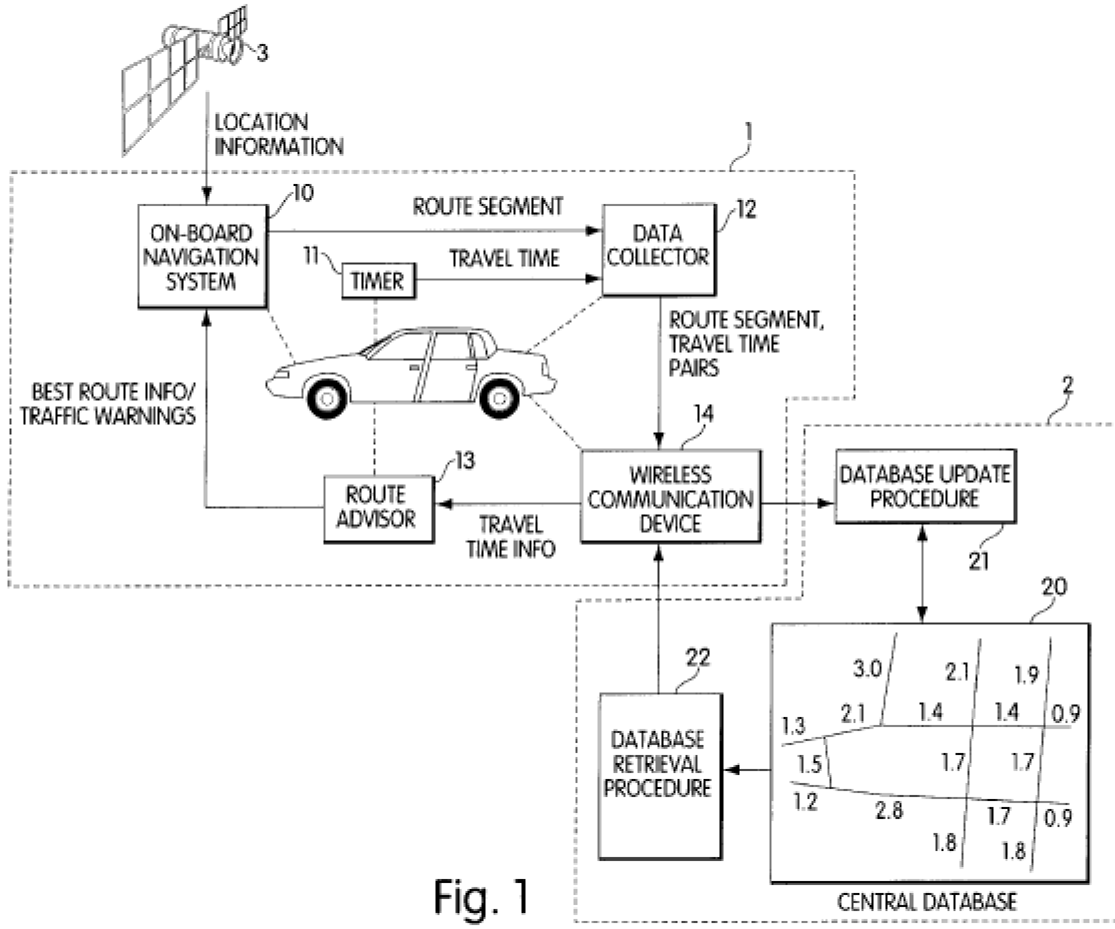


Fig. 1

(*Id.*, Fig. 1.) *Golding* explains that central database 2 includes a database retrieval procedure 22 (*id.*, 4:31-33, 5:29-31, Fig. 1), and the client-side vehicle navigation system 1 includes a route advisor 13 (*id.*, 4:31-33, 4:49-50, Fig. 1). Figure 2 of *Golding* depicts an example of data stored by central database 2:

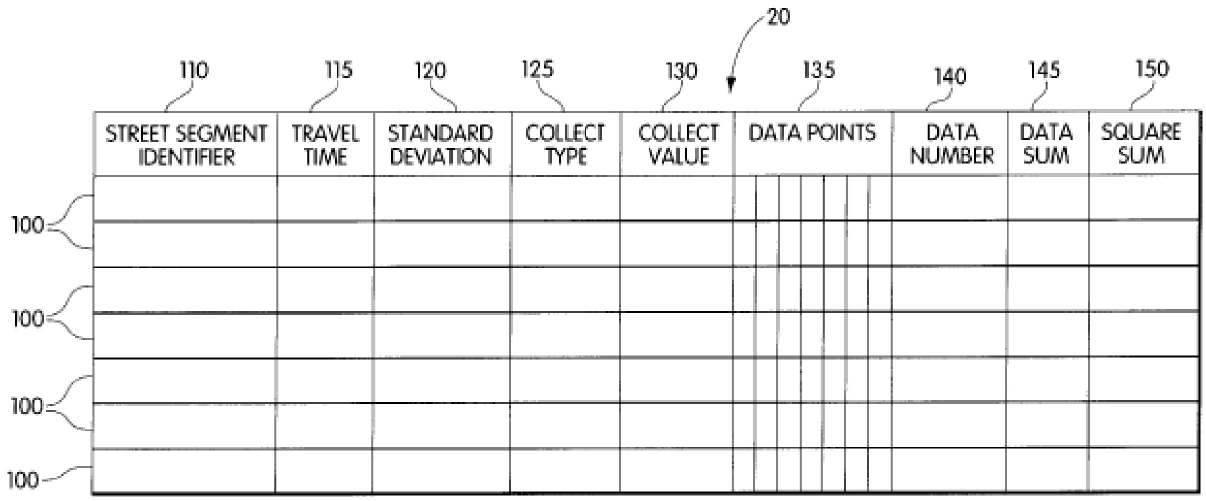


Fig. 2

(*Id.*, 4:26-27, 6:11-27, Fig. 2.)

70. According to *Golding*, "in order to limit the required memory, the route advisor [13] can have travel time information for only a portion of the map database in which the automobile is presently located. The route advisory could then obtain any additional travel time information from the central database, as needed." (*Id.*, 4:53-58.) In other words, before a route is planned, travel time information is only obtained as to the present location of the automobile. However, "[w]hen planning a route, the route advisor 13 can contact the central database 2 to obtain updated information for the locations of interest." (*Id.*, 6:32-34.) This is similar to the process in *Xu* (*see, e.g.*, Ex. 1004 at 13:26-14:4), since *Golding* starts its route planning process by analyzing data from central database 2 regarding a geographic area within which the vehicle is currently located ("searching the

database for traffic information specific to a coverage area including the location of the navigation device"). That is, both *Xu* and *Golding* provide techniques for limiting the required memory of a client-side device. Whereas *Xu* teaches a block flagging process, discussed above, in which unrelated data is discarded, *Golding* teaches a process that is in some ways more efficient (e.g., from a data transmission perspective) since data is only transmitted from the database to the automobile as needed. For example, *Golding* explains that if the needed information to plan a route is not in this "coverage area" ("determining that the coverage area is different from one or more areas in navigation coverage defined at least by the origination and the destination"), *Golding* discloses retrieving traffic and map data for additional geographic areas from central database 2 ("searching the database for selected traffic information specific to the one or more areas"). (Ex. 1006 at 4:53-58, 6:32-34; *see also* Ex. 1001 at 10:35-62 (describing a similar process).) (*See also* my analysis and citations above in VII.B.)

71. One of ordinary skill in the art would have been motivated to modify *Xu* to analyze data from the database for [traffic information or weather information] specific to a coverage area including the location of the navigation device" (at the database), determine that the coverage area is different from one or more areas in navigation coverage defined at least by the origination and the destination, and analyze data from the database for selected traffic information

specific to the one or more areas" in the "navigation coverage" (at the database), similar to the operation disclosed in *Golding*. One of ordinary skill would have been motivated to modify *Xu* in this way to limit the required memory at in-vehicle device 21, as suggested by *Golding*. (Ex. 1006 at 4:53-58.) In particular, as suggested by *Golding*, to achieve a reduction in required memory at a vehicle navigation device, a determination is performed to determine that the coverage area is different from one or more areas in navigation coverage defined at least by the origination and the destination. (*See* Ex. 1006 at 4:53-58, 6:32-34.) This allows the vehicle navigation device to find any additional data needed after a request for planning a route is received, whereby the database providing the additional data searches for and sends the data. (*See id.*)

72. One of ordinary skill also would have also been motivated to modify *Xu* in this way to limit the amount of processing required to be performed at in-vehicle device 21, limiting the need to determine data from the database that is or is not applicable to in-vehicle device 21's current navigation needs. Moreover, one of ordinary skill would have also recognized that, by using *Golding*'s technique, the amount of data that the database needs to transmit is significantly reduced (e.g., rather than sending all of its data, the database only needs to send data that is actually applicable to a vehicle's location or route), providing savings in resources, costs, and performance.

73. One of ordinary skill would have recognized that the operations in *Golding* are similar to the block flagging performed in *Xu*, and thus that modifying *Xu* in this way would have had predictable results. As modified, one of ordinary skill would have understood that in-vehicle device 21 would, like in *Golding*, contact traffic service center 60 to obtain additional and updated information for the locations of interest. (*See* Ex. 1006 at 6:32-34) Accordingly, one of ordinary skill in the art would have understood that implementing such a modification would have been common sense, predictable, and within the realm of knowledge of one skilled in the art at the time of the alleged invention.

E. Claims 8, 16, 22, and 29 of the '234 Patent

1. The Combination of *Xu* and *Trovato* Discloses the Features of Claims 8, 16, 22, and 29

74. In my opinion, the combination of *Xu* and *Trovato* discloses all of the features recited in claims 8, 16, 22, and 29 of the '234 patent.

75. As described below, the combination of *Xu* and *Trovato* discloses the features of claim 8:

Claim Language	*Xu* and *Trovato*
8. The method of claim 1 wherein turn-by-turn instructions are	*Xu* discloses that the "driver interface 28 includes a microphone . . . and loud-speaker to permit drivers to interact with the in-vehicle device 21." (Ex. 1004 at

Claim Language	*Xu* and *Trovato*
communicated via audio media to a user of the navigation device when traversing the planned route.	7:28-31.) *Xu* does not explicitly recite "turn-by-turn instructions are communicated via audio media to a user of the navigation device when traversing the planned route." However, one of ordinary skill in the art at the time of the alleged invention would have been motivated to modify *Xu* to include these limitations in view of *Trovato*, as discussed below.

76. *Trovato* is directed to a "travel direction speaking system." (Ex. 1005 at Abstract.) *Trovato* discloses that a "computer prepares driving instructions based on the route with each driving instruction including the spatial position (longitude and latitude) of the turn at which the driving instruction applies." (*Id.*, 2:8-11.) *Trovato* explains that its "system includes a Global Positioning System (GPS) unit that provides the GPS determined position of the laptop computer. The computer compares the GPS reading to the spatial position or setpoint and outputs the instruction when the two positions are within a specified range of each other." (*Id.*, 2:11-16.) "The range can be determined based on a time period required to travel from the current position to a position associated with a speech initiation point at which the instructions should be spoken. The time period accounts for the amount

of time required to speak the directions, for the reaction time of the driver at the speed that the laptop computer is moving," as well as "driving conditions, road conditions, personal preference, etc." (*Id.*, 2:16-27.) The system in *Trovato* includes a "text to voice unit that converts the text driving instructions into a voice signal." (*Id.*, 2:34-35.) *Trovato* discloses that, by performing its operations, it can ensure that "there is enough time to speak the directions sufficiently in advance of the turn to allow the driver to make the turn." (*Id.*, 1:58-60.)

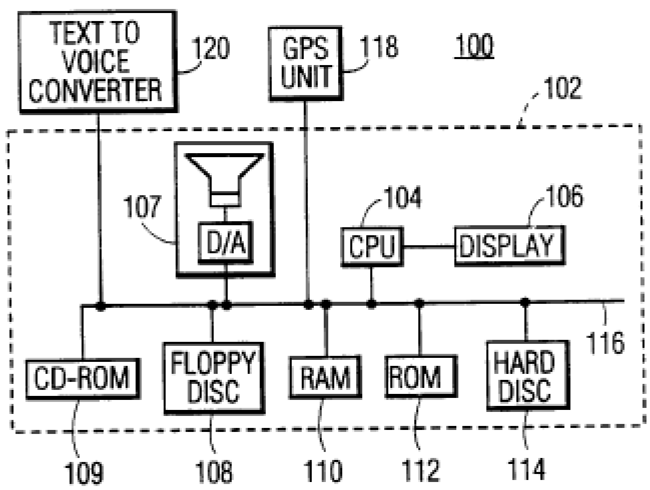


FIG. 1

(*Id.*, Fig. 1 (depicting the system in *Trovato*, including GPS unit 118 and text to voice converter 120).)

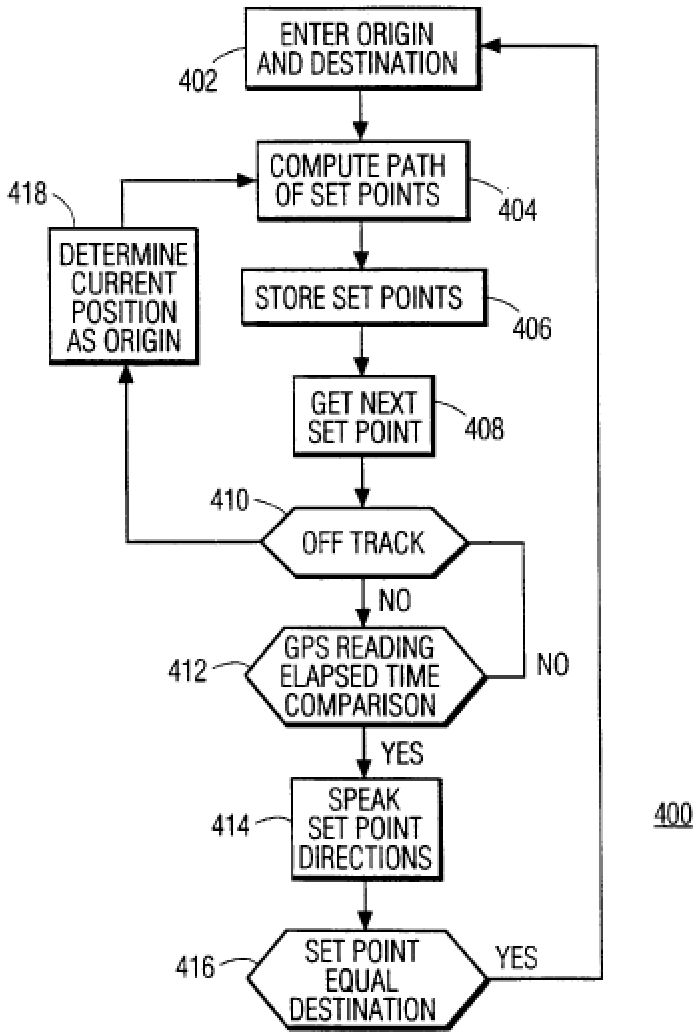


FIG. 4

(*Id.*, 5:64-67, Fig. 4 (depicting the process that is performed in determining which direction to issue and when to issue the direction).) (*See also* my analysis and citations above in VII.C.)

77. One of ordinary skill in the art would have been motivated to modify *Xu* such that turn-by-turn instructions are communicated via audio media to a user

of the navigation device when traversing the planned route, similar to the manner disclosed in *Trovato*. One of ordinary skill would have recognized that both *Xu* and *Trovato* are in the same field of navigation devices (*see, e.g.*, Ex. 1004 at Abstract; Ex. 1005 at Abstract), including navigation devices that take into account road and traffic conditions to plan routes (*see, e.g.*, Ex. 1004 at Abstract; Ex. 1005 at 2:26-27). One of ordinary skill would have been motivated to modify *Xu* include such turn-by-turn audio instructions since *Trovato* suggests that doing so can help ensure that a "driver has enough time to listen to the instructions and make the change in direction." (Ex. 1005 at 1:35-36.) Moreover, one of ordinary skill would have recognized that *Xu* was ready for improvement to include this feature since *Xu* already includes a "driver interface 28 [that] includes a microphone . . . and loud-speaker to permit drivers to interact with the in-vehicle device 21." (Ex. 1004 at 7:28-31.) In addition, one of ordinary skill would have recognized that using turn-by-turn audio instructions as in *Trovato* improves the usability and safety of the route planning system as drivers can keep their view on the traffic in front of them, rather than reading text directions. Indeed, such audio-based turn-by-turn directions were commonplace at the time of the alleged invention.

78. Thus, modifying driver interface 28 to also provide turn-by-turn instructions that are communicated via audio media (e.g., by converting text driving instructions into a voice signal, as in *Trovato*) to a user of the navigation

device when traversing the planned route, would have been a predictable modification of *Xu* that would not have otherwise affected *Xu*'s operation, particularly since this modification relates simply to the output format of data. Accordingly, one of ordinary skill in the art would have understood that implementing such a modification would have been common sense, predictable, and within the realm of knowledge of one skilled in the art at the time of the alleged invention.

79. As described below, the combination of *Xu* and *Trovato* discloses the features of claim 16:

Claim Language	***Xu* and *Trovato***
16. The method of claim 9 wherein turn-by-turn instructions are communicated via audio media to a user of the navigation device when traversing the planned route.	The combination of *Xu* and *Trovato* discloses that turn-by-turn instructions are communicated via audio media to a user of the navigation device when traversing the planned route, for at least the same reasons discussed above for claim 8. (*See* my analysis and citations above, including reasons why one skilled in the art would have been motivated to make the above modifications, in ¶¶ 76-78.)

80. As described below, the combination of *Xu* and *Trovato* discloses the features of claim 22:

Claim Language	***Xu* and *Trovato***
22. The system of claim 17 wherein turn-by-turn instructions are communicated via audio media to the user.	The combination of *Xu* and *Trovato* discloses that turn-by-turn instructions are communicated via audio media to the user, for at least the same reasons discussed above for claim 8. (*See* my analysis and citations above, including reasons why one skilled in the art would have been motivated to make the above modifications, in ¶¶ 76-78.)

81. As described below, the combination of *Xu* and *Trovato* discloses the features of claim 29:

Claim Language	***Xu* and *Trovato***
29. The system of claim 24 wherein turn-by-turn instructions are communicated via audio media to the user.	The combination of *Xu* and *Trovato* discloses that turn-by-turn instructions are communicated via audio media to the user, for at least the same reasons discussed above for claim 8. (*See* my analysis and citations above, including reasons why one skilled in the art would have been motivated to make the above

Claim Language	*Xu* and *Trovato*
	modifications, in ¶¶ 76-78.)

2. The Combination of *Xu*, *Golding*, and *Trovato* Discloses the Features of Claims 8, 16, 22, and 29

82. As I discuss above, the combination of *Xu* and *Trovato* discloses all of the limitations of claims 18, 16, 22, and 29. However, as I note in Part VII.D.2, I have been asked to consider a scenario in which the Patent Owner argues that *Xu* does not disclose "searching the database for [traffic information or weather information] specific to a coverage area including the location of the navigation device," "determining that the coverage area is different from one or more areas in navigation coverage defined at least by the origination and the destination," and "searching the database for selected traffic information specific to the one or more areas," as recited in independent claims 1 and 9, or similarly recited in independent claims 17 and 24. In particular, I have been asked to interpret the claims under the assumption that the "searching the database" limitations must be performed at the database (whereas *Xu* performs such operations at the client) and/or that the flagged geographical blocks including the location of in-vehicle device 21 in *Xu* do not correspond to a "coverage area," as claimed. As I discuss in Part VII.D.2, in my opinion, based on the narrower understanding of the claims, the combination of

Xu and *Golding* also discloses all of the features recited in claims 1-7, 9-15, 17-21, 23-28, and 30 of the '234 patent.

83. For at least the same reasons that I discuss above in Part VII.E.1, one of ordinary skill in the art at the time of the alleged invention would have been motivated to modify the combination of *Xu* and *Golding* to include the limitations of claims 8, 16, 22, and 29, in view of *Trovato*. The resulting combination of *Xu*, *Golding*, and *Trovato* would thus include a system that performs the processes recited in claims 8, 16, 22, and 29.

84. While *Golding* is relied upon to modify certain portions of the system and processes of *Xu* in Part VII.D.2, none of these portions relate to the output of the route in *Xu*. Thus, one of ordinary skill in the art would have recognized that the combined system and processes of *Xu* and *Golding* would have been modified for the same reasons that the system and processes of *Xu* would have been modified, with the same predictable results.

VIII. CONCLUSION

85. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: August 14, 2015

By: [signature]
William R. Michalson

Appendix A

Curriculum Vitae for
William R. Michalson

Research Associates, LLC
26 West Main Street, STE 2
Dudley, MA 01571
Email: wrm@wmichalson.com
Tel: (508) 461-6242
Cell: (508) 331-4134

1. Personal:

1.1 Education

Ph.D. in Electrical Engineering, 1989, Worcester Polytechnic Institute, Worcester, Massachusetts.

Dissertation:	*A Parallel Computer Architecture for Real-Time Decision Making*. The dissertation develops a hierarchical, multiple processor, computer architecture for executing artificial intelligence programs in real-time. Dissertation Directors: Dr. Peter E. Green and Dr. R. James Duckworth.
Minor Areas:	Minor sequences completed in Mathematics and Physics.
Specialties:	Area examinations passed in the fields of Computer Architecture, Probabilistic Systems Analysis, and State Space Analysis.

M.S. in Electrical Engineering, 1985, Worcester Polytechnic Institute, Worcester, Massachusetts.

Specialties:	The courses taken stressed Computer Architecture, Communications Systems, and Solid-State Physics.

B.S. in Electrical Engineering, 1981, Syracuse University, Syracuse, New York.

1.2 Work experiences - Academic.

1991-Present Worcester Polytechnic Institute

Professor of Electrical and Computer Engineering; Professor of Computer Science.

Effective July 1, 2005	Promoted to the rank of Full Professor (Professor of Electrical and Professor of Computer Science)
November 17, 2004	Appointed dual professorship, adding the title of Associate Professor of Computer Science.
July 1, 1998	Granted tenure and promoted to the rank of Associate Professor.
August 1, 1992	Assistant Professor of Electrical Engineering (tenure-track).
August 1, 1991	Visiting Assistant Professor of Electrical Engineering.
January 1, 1990	Adjunct Assistant Professor of Electrical Engineering.

1.3 Work experiences other than teaching (chronological).

2012-2014 Grid Roots, LLC

Grid Roots, LLC is a company which was formed in 2012 for the purpose of commercializing a navigation and tracking device for use by children and the elderly to allow caregivers to non-intrusively monitor their activities. The system under development integrates GPS, inertial and beacon-based navigation technologies to develop a system for users to track deployed devices. My responsibilities within Grid Roots, LLC relate to hardware and software engineering, as well as the development of IP related to tracking individuals.

1995-Present Research Associates, LLC

Research Associates, LLC is a company I formed in which I perform engineering and consulting in the areas of computer systems, communications and navigation. All of my litigation-related and other consulting activities are performed through Research Associates, LLC.

1988-1991 Raytheon Company

Subsequent to receiving my Ph. D., I returned to the Equipment Division of the Raytheon Company. Shortly after I returned, I was promoted to a title of Engineer, Design and Development which was the highest title I could hold based on my level of education and years of experience. Within a year, I was selected to sit on the engineering staff of a newly formed System Engineering Department of the Division's Computer and Displays Laboratory. In this department I acted primarily as a consultant to other departments within the laboratory. My responsibilities ranged from leading the hardware/software development of supercomputer-class computer systems to performing applied research into the exploitation of new technology. My role was similar to that of a Principle Investigator in an academic setting as I was responsible for securing funding and personnel, leading research efforts, interacting with the research sponsor, and reporting results. At the time of my departure I was involved with the following projects:

Fault-Tolerant Multiprocessor

The development of a highly fault tolerant, highly reliable, real-time computer system intended for long-duration spaceborne applications. This system is designed to produce in excess of one gigaoperation per second of raw processing power.

Optimal Task Allocation

A program of applied research into the use of Genetic Algorithms for deriving optimal mappings of software tasks to the hardware processing elements in distributed systems.

Performance Modeling and Scaling

This project focused on the development of simulation models for characterizing the performance of a large scale multiple processor system. These models formed a basis for predicting system performance for several different hardware configurations to ensure compliance with system specifications.

High Clutter Signal Detection

A program of applied research into the use of Neural Networks to detect the presence of targets in extremely high clutter environments.

Power Efficient Computing

A program of applied research into an Integrated Optical computer structure that is designed to maximize the number of computations that can be performed per unit of power.

1985-1988 Raytheon Company (Leave of Absence)

In 1985 I became one of two people in the Equipment Division to receive Aldo Miccioli Fellowships. This Fellowship was awarded to allow me to pursue full-time study towards the Ph.D. degree. I returned to Raytheon during the summer of 1986, but otherwise remained on leave of absence to dedicate my time to my studies.

1982-1985 Raytheon Company

Engineer in the VLSI Design Department of the Computer and Displays Laboratory within Raytheon's Equipment Division. I was lead engineer for the design of several semi-custom VLSI circuits for both signal and data processing applications.

1981-1982 Raytheon Company

Engineer in the Cursive Displays Department of the Computer and Displays Laboratory. I designed and debugged circuit assemblies which were used in vector displays for air traffic control applications.

1.4 Consulting experiences.

1.4.1 Law-Related

TracBeam, L.L.C. v. T-Mobile US, Inc., et al.,
Retained by Baker Botts on behalf of defendant T-Mobile US, Inc., et al. Case before the Eastern District of Texas (6:14-cv-678-RWS). See also IPR2015-01681, IPR2015-01682, IPR2015-01684, IPR2015-01686, IPR2015-01687, IPR2015-01708, IPR2015-01709, IPR2015-01711, IPR2015-01712, and IPR2015-01713. Retained 7/15 to present.

Bradium Technologies LLC v. Microsoft Corporation,
Retained by Perkins Coie on behalf of defendant Microsoft Corporation. Case before the Eastern District of Delaware (15-0031-RGA). See also IPR2015-01432, IPR2015-01434, and IPR2015-01435. Retained 3/15 to present.

ACQIS LLC v. EMC Corp.,
Retained by Gibson Dunn on behalf of defendant EMC Corp. Case before the District of Massachusetts (1:14-cv-13560). Retained 2/15 to present.

Locata LBS LLC v. YellowPages.com LLC,
Retained by Baker Botts on behalf of defendant YellowPages.com. Case before the Central District of California (2:13-cv-07664). See also IPR2015-00151. Retained 9/14 to 4/15. Matter settled.

M/A-COM Technology Solutions Holdings, Inc. v. Laird Technologies, Inc.
Retained by Erise IP on behalf of Laird Technologies, Inc., for invalidity consulting regarding U.S. Patent No. 6,272,349. Retained 6/14 to present.

Certusview Technologies, LLC v. S&N Locating Services, LLC and S&N Communications, Inc.,
Retained by Baker &McKenzie on behalf of defendant S&N. Patents-in-suit are U.S. Patents 8,265,344, 8,290,204, 8,340,359, 8,407,001, and 8,532,341. Case before the Eastern District of Virginia, (2:13-cv-346). Deposed 11/8/14; Retained 6/14 to 12/14.

adidas AG and adidas America, Inc. v. Under Armour, Inc. and MapMyFitness, Inc.
Retained by Kilpatrick Townsend on behalf of plaintiff adidas. Case before the District of Delaware, (1:14-cv-00130). Retained 5/14 to present.

GeoTag, Inc., v. AT&T Mobility LLC and AT&T Services, Inc.,
Retained by Baker Botts as an expert on behalf of defendant AT&T. Patent-in-suit is U.S. Patent 5,930,474. Case before the Northern District of Texas, Dallas Division, (3:13-cv-00169). Deposed 5/29/14; Retained 1/14 to 9/14. Matter settled.

Nokia Corp v. HTC Corp.
Retained by Quinn Emanuel as an expert on behalf of defendant HTC. Case being litigated in Germany. Patent number EP0766811B1. Retained 12/13 to 2/14. Matter settled.

Porto Technology, Co., Ltd. et al. v. Cellco Partnership d/b/a Verizon Wireless
Retained by Wiley-Rein as an expert on behalf of defendant Verizon. Case before the United States District Court for the Eastern District of Virginia (Case No. 3:13-cv-00265). Retained 10/13 to 2/14. Matter dismissed.

Nokia Corp v. HTC Corp.
Retained by McDermott Will and Emery and White & Case as an expert on behalf of defendant HTC. Case before the United States District Court for the District of Delaware (Case No. Case No. 1:12-cv-00550-UNA and Case No. 1:12-cv-551-UNA. Retained 6/13 to 2/14. Matter settled.

NXP B.V. v. Research In Motion, Ltd., et al.
Retained by Fish and Richardson as an expert on behalf of defendant Research In Motion. Patent-in-suit is U.S. Patent 6,501,420. Case before the United States District Court for the Middle District of Florida (Case No. 6:12-cv-00498). Deposed 9/18/13; Testified in Court: 4/1/14 and 4/2/14; Retained 5/13 to 4/14.

Vehicle IP LLC v. Wal-Mart Stores Inc., et al.
Retained by Polsinelli-Shugart, as an expert on behalf of defendant Werner Enterprises. Patent-in-suit is U.S. Patent 5,694,322. Case before the United States District Court for the District of Delaware (Case No. 1:10-cv-00503). Deposed 7/15/13 and 9/20/13; Testified in Court: 9/27/13 and 9/30/13; Retained 4/13 to 9/13.

TracBeam, LLC v. Google Inc.
Retained by Quinn-Emanuel as an expert on behalf of defendant Google. Patents-in-suit are U.S. Patents 7,764,231 and 7,525,484. Case before the United States District Court for the Eastern District of Texas (6:11-cv-00093). Deposed 2/5/14; Retained 3/13 to 6/14.

Microsoft Corporation and Google Inc., v. GeoTag, Inc.
Retained by Perkins-Coie as an expert on behalf of plaintiff Microsoft Corporation. Patent-in-suit is U.S. Patents 5,930,474. Case before the United States District Court for the District of Delaware (1:11-cv-00175). Retained 1/13 to present.

GeoTag, Inc., v. Frontier Communications Corp., et al.,
Retained by multiple firms as an expert on behalf of defendants. Patent-in-suit is U.S. Patents 5,930,474. Case before the Eastern District of Texas, Marshall Division, (2:10-cv-00265; other defendants are listed in case numbers 2:10-cv-00265, 2:10-cv-00272, 2:10-cv-00437, 2:10-cv-00569, 2:10-cv-00570, 2:10-cv-00571, 2:10-cv-00572, 2:10-cv-00573, 2:10-cv-00574, 2:10-cv-00575, 2:10-cv-00587, 2:11-cv-00175, 2:11-cv-00404, 2:11-cv-00421, 2:11-cv-00424, 2:11-cv-00425, 2:11-cv-00570, 2:12-cv-00043, 2:12-cv-00051, 2:12-cv-00436, 2:12-cv-00438, 2:12-cv-00439, 2:12-cv-00441, 2:12-cv-00442, 2:12-cv-00444, 2:12-cv-00445, 2:12-cv-00446, 2:12-cv-00447, 2:12-cv-00448, 2:12-cv-00449, 2:12-cv-00450, 2:12-cv-00452, 2:12-cv-00454, 2:12-cv-00456, 2:12-cv-00459, 2:12-cv-00460, 2:12-cv-00462, 2:12-cv-00464, 2:12-cv-00466, 2:12-cv-00468, 2:12-cv-00469, 2:12-cv-00470, 2:12-cv-00471, 2:12-cv-00473, 2:12-cv-00474, 2:12-cv-00475, 2:12-cv-00476, 2:12-cv-00476, 2:12-cv-00477, 2:12-cv-00480, 2:12-cv-00481, 2:12-cv-

00482, 2:12-cv-00482, 2:12-cv-00483, 2:12-cv-00486, 2:12-cv-00487, 2:12-cv-00520, 2:12-cv-00521, 2:12-cv-00523, 2:12-cv-00524, 2:12-cv-00525, 2:12-cv-00527, 2:12-cv-00528, 2:12-cv-00530, 2:12-cv-00532, 2:12-cv-00534, 2:12-cv-00535, 2:12-cv-00536, 2:12-cv-00537, 2:12-cv-00542, 2:12-cv-00543, 2:12-cv-00545, 2:12-cv-00547, 2:12-cv-00548, 2:12-cv-00549, 2:12-cv-00550, 2:12-cv-00551, 2:12-cv-00552, 2:12-cv-00555, 2:12-cv-00556, 2:12-cv-00570, 2:12-cv-00572, 2:12-cv-00573, 2:12-cv-00575, 2:12-cv-00587, 3:13-cv-00217). Deposed 5/29/14; Retained 1/13 to 9/14.

MOSAID Technologies Inc., v. Realtek Semiconductor Corporation
Retained by Sidley Austin, LLP as an expert on behalf of defendant Realtek Semiconductor Corporation. Patents-in-suit are U.S. Patents 5,131,006; 5,151,920; 5,422,887; 5,706,428; 6,563,786; and 6,992,972. Case before the United States District Court for the Eastern District of Texas (Tyler Division) (Case No. 2:11-cv-00179). Retained 12/12 to 12/12. Matter settled.

Hoyt A. Flemming v. Cobra Electronics Corporation
Retained by Sidley Austin, LLP as an expert on behalf of defendant Cobra Electronics Corporation. Patents-in-suit are U.S. Patents RE39038, RE40653 and RE41905. Case before the United States District Court for the District of Idaho (Case No. 1:12-cv-00392). Retained 11/12 to 06/13. Matter settled.

LBS Innovations LLC v. Aaron Bros., Inc., et al.
Retained as an expert on behalf of defendants Whole Foods Marketplace, Comerica, Hotels.com, Academy, Ltd., and Homestyle Dining. Patent-in-suit is U.S. Patent 6,091,956. Case before the Eastern District of Texas, Marshall Division, (Case No. 2:11-cv-00142-MHS-CMC. Deposed 10/5/12; Retained 7/12 to 12/12. Plaintiff moved to dismiss.

Advanced Media Networks, L.L.C. v. Gogo LLC et al.
Retained by Sidley Austin, LLP as an expert on behalf of defendant Gogo. Patent-in-suit is U.S. Patent 5,960,074. Case before the United States District Court for the Central District of California (Case No. 11-cv-10474). Deposed 2/6/13. Retained 7/12 to 8/13.

Walker Digital, LLC v. Google Inc.
Retained by O'Melveny & Meyers, LLP as an expert on behalf of defendant Google Inc. Patents-in-suit are U.S. Patents 6,199,014. Case before the United States District Court for the District of Delaware (Case No. 1:11-cv-00309-SLR). Deposed 2/27/13 - 2/28/13. Retained 6/12 to present (case stayed as of 8/13).

Silver State Intellectual Technologies, Inc. v. Garmin International, Inc., et al.
Retained by Erise IP, P.A. as an expert on behalf of defendants Garmin International, Inc. and Garmin USA, Inc. Patents-in-suit are U.S. Patents 6,525,768; 6,529,824; 6,542,812; 7,343,165; 7,522,992; 7,593,812; 7,650,234; 7,702,455 and 7,739,039. Case before the United States District Court for the District of Nevada (Case No. 2:11-cv-1578). Deposed 2/19/14; Testified in Court: 5/21/15; Retained 4/12 to 5/15.

Beacon Navigation GmbH v. Toyota Motor Corporation, et al.

Retained by Kirkland & Ellis, LLP on behalf of defendants Toyota Motor Corporation; Toyota Motor North America, Inc.; Toyota Motor Sales, U.S.A. Inc.; Toyota Motor Engineering & Manufacturing North America, Inc.; Toyota Motor Manufacturing, Indiana, Inc.; Toyota Motor Manufacturing, Kentucky, Inc.; Toyota Motor Manufacturing Mississippi, Inc.; Mazda Motor Corporation; Mazda Motor of America, Inc.; Fuji Heavy Industries, Ltd.; Fuji Heavy Industries U.S.A. Inc.; Subaru of America, Inc.; Jaguar Land Rover North America, LLC; Jaguar Cars Limited; Land Rover; Volvo Car Corporation; and Volvo Cars of North America, LLC; Adduci Mastriani & Schaumberg, LLP on behalf of defendants Suzuki and Garmin; Crowell-Moring on behalf of General Motors; Dickstein Shapiro on behalf og Chrysler Group, LLC; Finnegan, Henderson, Farabow, Garrett & Dunner on behalf of Bayerische Motoren Werke AG, BMW of North America, LLC, and BMW Manufacturing Co. LLC; Fish & Richardson on behalf of Honda Motor Co., Ltd., Honda North America, Inc., American Honda Motor Co., Inc., Honda Manufacturing of Alabama, LLC, Honda Manufacturing of Indiana, LLC, and Honda of America, Mfg., Inc.; Frommer Lawrence and Haug, LLP on behalf of Dr. Ing. h.c.F. Porsche AG and Porsche Cars North America, Inc.; Hogan Lovells on behalf of Daimler AG, Mercedes-Benz USA, LLC, or Mercedes-Benz U.S. International, Inc.; Quinn-Emanuel on behalf of Nissan and Ford. Case before the US International Trade Commission, Washington D.C., in the matter of: "Certain Automotive Navigation Systems, Components Thereof, and Products Containing Same, Inv. No. 337-TA-814. Case withdrawn by Plaintiff. Retained 1/12 – 4/12.

Beacon Navigation GmbH v. Toyota Motor Corporation, et al.
Retained by Kirkland & Ellis, LLP on behalf of defendants Toyota Motor Corporation; Toyota Motor North America, Inc.; Toyota Motor Sales, U.S.A. Inc.; Toyota Motor Engineering & Manufacturing North America, Inc.; Toyota Motor Manufacturing, Indiana, Inc.; Toyota Motor Manufacturing, Kentucky, Inc.; Toyota Motor Manufacturing Mississippi, Inc.; Mazda Motor Corporation; Mazda Motor of America, Inc.; Fuji Heavy Industries, Ltd.; Fuji Heavy Industries U.S.A. Inc.; Subaru of America, Inc.; Jaguar Land Rover North America, LLC; Jaguar Cars Limited; Land Rover; Volvo Car Corporation; and Volvo Cars of North America, LLC. Multiple cases before the United States District Court for the District of Delaware. Case numbers 1:11-cv-00942-UNA, 1:11-cv-00941-UNA, 1:11-cv-00951-UNA, 1:11-cv-00952-UNA, 1:11-cv-00936-UNA, 1:11-cv-00937-UNA, 1:11-cv-00955-UNA, 1:11-cv-00959-UNA, and 1:11-cv-00960-UNA. Currently stayed. Retained 1/12 to Present.

Beacon Wireless Solutions, Inc., et al., v. Garmin International, Inc., et al.
Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of defendant Garmin. Matter involves alleged trade secret misappropriation. Case before the United States District Court for the Western District of Virginia, Harrisonburg Division (Case No. 5:11-cv-00025). Testified in Court: 5/25/12. Retained 12/11 to 5/25/12.

Tramontane IP, LLC v. Garmin Int'l, Inc., et al.
Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of defendant Garmin. Patents-in-suit are U.S. Patents 6,526,268 and 7,133,775. Case before the United States District Court for the Eastern District of Virginia (Case No. 1:2011-cv-00918). Case Settled. Retained 11/11 to 12/11.

Sourceprose, Inc. v. AT&T, Inc., MetroPCS Communications, Inc., *et al.*
Retained by Kilpatrick Townsend as an expert on behalf of defendant AT&T. Patents-in-suit are US Patent Nos. 7,142,217 and 7,161,604. Case before the United States District Court for the Western District of Texas, Austin Division. Case number 1:11-cv-00117. Retained 11/11 to present.

Furuno Electric Co., Ltd. and Furuno U.S.A., Inc. v. Honeywell International, Inc.
Retained by Quinn-Emanuel as an expert on behalf of complainant Furuno. Case before the US International Trade Commission, Washington D.C., in the matter of: "Certain GPS Navigation Products, Components Thereof, and Related Software," Investigation number 337-TA-810. Patents-in-suit are U.S. Patent Nos. 6,084,565; 7,095,367; 7,089,094; and 7,161,561. Case settled. Retained 8/11 – 12/11.

Honeywell International, Inc. v. Furuno Electric Co., Ltd. and Furuno U.S.A., Inc.
Retained by Quinn-Emanuel as an expert on behalf of respondent Furuno. Case before the US International Trade Commission, Washington D.C., in the matter of: "Certain GPS Navigation Products, Components Thereof, and Related Software," Investigation number 337-TA-783. Patents-in-suit are U.S. Patent Nos. 7,209,070; 6,865,452; 5,461,388; and 6,088,653. Case Settled. Retained 8/11 – 12/11.

Triangle Software, Inc. v. Garmin International, Inc.
Retained by Weil, Gotshal & Manges, LLP., as an expert on behalf of defendant Garmin. Patents-in-suit are US Patents 7,557,730, 7,221,287, 7,375,649, 7,508,321 and 7,702,452. Case before the United States District Court, Eastern District of Virginia, Case No. 1:10-cv-1457 CMH/TCB. Deposed 7/28/11; Testified in Court: 11/3/11 (jury trial). Retained 4/11 to 11/11.

Garmin International, Inc. v. Pioneer Corporation and Pioneer Electronics (USA), Inc.
Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of plaintiff Garmin. Patents-in-suit are U.S. Patents 5,365,448; 5,424,951; and 6,122,592. Case before the United States District Court for the District of Kansas. Case No. 10-CV-2080 JWL/GLR. Declarative Judgment action stayed. Retained 3/11 to 11/11.

Visteon Global Technologies, Inc. And Visteon Technologies, LLC v. Garmin International, Inc.
Retained by Shook, Hardy and Bacon as an expert on behalf of defendant Garmin. Patents-in-suit are US Patents 5,544,060, 5,654,892, 5,832,408, 5,987,375 and 6,097,316. Case before the United States District Court, Eastern District of Michigan, Case No. 2:10-cv-10578--PDB-MAR. Deposed 10/9/12; Retained 12/10 to present.

Thomson Licensing SAS and Thomson Licensing, LLC. v. Realtek Semiconductor Corporation
Retained by Sidley-Austin as an expert on behalf of respondent Realtek Semiconductor. Case before the US International Trade Commission, Washington D.C., in the matter of: "Certain Liquid Crystal Display Devices, Including Monitors, Televisions, Modules, And Components Thereof," Investigation number 337-TA-741. Patent-in-suit is US Patent 6,121,941. Deposed 6/29/11; Testified in Court: 9/15/11 and 9/16/11. Retained 11/10 – 9/11.

Ambato Media, LLC. v. Clarion Co., LTD., *et al.*
Retained by Traurig-Greenberg as an expert on behalf of defendant Garmin. Patent-in-suit is US Patent 5,432,542. Case before the United States District Court for the Eastern District Of Texas, Marshall Division. Case number 2:09-CV-242. Deposed 4/26/12 and 5/10/12; Testified in Court: 7/11/12. Retained 10/10 to present.

Gabriel Technologies Corporation and Trace Technologies, LLC, v. Qualcomm Incorporated, Snaptrack, Inc. and Norman Krasner
Retained by Cooley-Godward as an expert on behalf of defendants Qualcomm, Snaptrack, and Krasner. Trade secret misappropriation case related to US Patents 6,377,209, 6,583,757, 6,661,372, 6,799,050, 6,861,980, 6,895,249, 7,254,402, 7,289,786, 7,319,876, 7,421,277, 7,446,655, 7,570,958, 7,574,195, and 7,660,588. Case before the Southern District of California San Diego Division, Case No. 08-cv-1992 MMA POR. Retained 6/10 to 7/12.

SiRF/CSR v. Global Locate/Broadcom Corporation
Retained by Wilmer-Hale as an expert on behalf of defendant Global Locate / Broadcom. Patents-in-suit are US Patents 5,663,735, 6,480,150, 6,519,466, 6,650,879, 6,882,827, 6,934,322, 7,412,157, 7,236,883, and 7,573,422. Case before the Central District of California, Case No. 8:06-cv-01216 and Case No. 8:10-cv-01281. Retained 9/10 to 1/11.

Pioneer Electronics v. Garmin Corporation
Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of respondent Garmin In the matter of Certain Multimedia Display and Navigation Devices and Systems, Components Thereof, and Products Containing Same; Inv. No. 337-TA-694. Patents-in-suit are U.S. Patents 5,365,448; 5,424,951; and 6,122,592. Case before the U.S. International Trade Commission. Deposed on 7/29/10; Testified at technology tutorial (8/27/20) and in the evidentiary hearing (9/20/10). Retained 4/10 to 9/10.

EMSAT Advanced Geo-Location Technology, LLC and Location Based Services LLC, v. AT&T Mobility, LLC
Retained by Baker-Botts as an expert on behalf of defendant AT&T Mobility, LLC. Patents-in-suit are U.S. Patents 7,289,763; 5,946,611; 6,324,404; and 6,847,822. Case before the U.S. District Court for the Northern District of Ohio, Eastern Division, Civil Action No. 4:08 CV 822. Deposed 5/4/10; Testified in Court: 5/10/10 (Markman hearing). Retained 12/09 to 3/11.

Tendler Cellular of Texas, LLC v. AT&T Mobility, LLC, et al.
Retained by Baker-Botts as an expert on behalf of defendants AT&T Mobility, LLC, et al. Patents-in-suit are U.S. Patents 7,447,508; 7,305,243; 7,050,818; and 6,519,463. Case before the U.S. District Court for the Eastern District of Texas (Tyler), Civil Action No. 6:09-CV-00115. Retained 8/09 to 7/10.

Ambit Corporation v. Delta Air Lines, Inc., and Aircell LLC.
Retained by Sidley Austin, LLP., as an expert on behalf of defendants Delta Airlines, Inc., and Aircell, LLC. Patent-in-suit is US patent 7,400,858. Case before the US District Court, District

of Massachusetts, Boston, Civil Action No. 1:09-CV-10217-WGY. Deposed 12/4/09; Testified in Court: 12/7/09 (evidentiary hearing), 7/10 (jury trial). Retained 8/09 to 7/10.

GPS Industries, Inc. and Optimal I.P. Holdings, L.P. v. Altex Corporation, et. al.
Retained by Hitchcock-Evert as an expert on behalf of defendants Altex Corporation, Deca International Corporation, Golflogix, Inc. and L1 Technologies. Patent-in-suit is US patent 5,364,093. Case before the US District Court, Northern District of Texas, Dallas Division, Civil Action No. 3-07-CV0831-K. Deposed 6/30/09. Retained 5/08 through 7/09.

Satellite Tracking of People, LLC v. Omnilink Systems, Inc.
Retained by DLA Piper as an expert on behalf of defendant Omnilink Systems, Inc.. Patent-in-suit is US patent RE39,909. Case before the US District Court, Eastern District of Texas, Marshall Division, Civil Action No. 2-08CV-116. 12/08 – 1/11.

SiRF Technology, Inc. v. Global Locate, Inc.
Retained by DLA Piper/WilmerHale as an expert on behalf of Global Locate. Patents-in-suit include US patents 6,304,216; 6,417,801; 6,606,346; 6,651,000; 6,704,651; 6,937,187; 7,043,363; 7,091,904; 7,132,980 and 7,158,080. Case before the US International Trade Commission, Washington D.C., in the matters of: "Certain GPS Devices and Products Containing Same," Investigation number 337-TA-602 (Global Locate, plaintiff) and "Certain GPS Chips, Associated Software and Systems, and Products Containing Same," Investigation number 337-TA-596 (SiRF Technologies, plaintiff). My work focused on the 7,043,363 and 7,091,904 patents in defense of Global Locate/Broadcom from June 2007 through March 2008. Deposed 1/18-1/19/08; testified at trial 3/18-3/19/08.

Intellectual Science and Technology
Retained Dykema Gossett, PLCC as a technical expert on patent infringement issues related to "suspend-to-RAM" technologies in personal computers. Pre-litigation work.

Intellectual Science and Technology, Inc., v. Sony, JVC and Panasonic
Retained Dykema Gossett, PLCC as a technical expert on patent infringement issues related to US Patent 5,748,575, US Patent 6,222,799, US Patent 6,785,198, US Patent 6,662,239 and US Patent 6,717,890. Sony Electronics Inc., case number 2:06-CV-10406, JVC Americas Corp., case number 2:06-CV-10409 and Panasonic Corporation of North America case number 2:06-CV-10412. Cases heard in United States District Court, Eastern District of Michigan, Southern Division. Expert for Intellectual Science and Technology, Inc. Dec 2006 – 2008..

Kirsch Technologies v. Xerox, Canon
Retained Dykema Gossett, PLCC as an Expert Witness on patent infringement issues related to US Patent 4,816,911, Canon case number CA 00-72775, Xerox case number CA 00-72778, cases heard in United States District Court, Eastern District of Michigan, Southern Division. Expert for Kirsch Technologies. Nov 2006 – 2008..

American Video Graphics v. ATI Technologies
Retained by Sidley, Austin, Brown & Wood, Dallas, TX as a technical expert on patent infringement issues related to US Patents 5,132,670, 5,109,520, 5,084,830, 4,761,642, 4,742,474,

4,734,690, 4,730,185 and 4,694,286. Hewlett-Packard Co., et al., defendants, case number CA 6:04-CV-379-LED and Sony Corporation of America et al., defendants, case number CA 6:04-CV-399-LED. Cases heard in United States District Court, Eastern District of Texas, Tyler Division. Expert for ATI Technologies, intervener. Jan 2005 – Sep 2005.

Microsoft v. EMC
Dewey Ballantine, LLP, Washington, D.C., as a technical expert on patent infringement issues related to US Patents 5,588,147; 5,689,700; 6,393,466; 6,424,151; 6,490,594; and 6,632,248. Wrote a declaration on behalf of Microsoft. Oct 2004 – Jan 2005.

Optimum Return v. Meier Brothers
Retained by Sidley, Austin, Brown & Wood, Dallas, TX as a technical expert on Copyright infringement allegations related to software owned by Optimum Return, LLC. Cyberkatz Consulting, Inc., Handsquare, LLC, Meier Brothers, et al., defendants, case number CA 3-03CV1064-D. Case heard in United States District Court, Northern District of Texas, Dallas Division. Expert for Meier Brothers. July 2004.

Parental Guide of Texas, Inc. v. Funai Corp., et. al.
Technical expert for defendants JVC and Panasonic in their dispute over non-infringement of US Patent number 4,605,964.

Elonex I.P. Holdings, LTD. and Elonex PLC, Phase II
Expert witness for defendants Chuntex, Acer, Tatung, Lite-On, Daewoo and Envision in their dispute with Elonex non-infringement and validity for US Patent numbers 5,389,952; 5,648,799; and 5,880,719.

Storage Computer Corporation vs. Veritas Software
Technical expert for the plaintiff in matters involving Patents US 5,257,367; US 5,893,919; and US 6,098,128.

Storage Computer Corporation vs. Seagate Technology LLC
Technical expert for the defendant in matters involving US Patent RE 34,100.

Elonex I.P. Holdings, LTD. and Elonex PLC, vs. Packard Bell et. al., CA 98-689-GMS
Expert witness for defendants ViewSonic Corp., Dell Computer Corporation, MAG Technology USA, Princeton Graphic Systems, Inc., Micron Electronics, Sony Electronics and Capetronic Computer USA in their dispute with Elonex non-infringement and validity for US Patent numbers 5,389,952; 5,648,799; and 5,880,719.

1.4.2 Engineering Consulting

Offspring Media Inc.
Technical consultant for the development of real-time auralization algorithms for integration into a consumer electronics product. Sep 2004.

Raytheon Company, Sudbury, MA

Development of techniques and requirements for implementing a fault tolerant computer system using software implemented fault tolerance (SIFT) techniques on commercial off-the-shelf processing hardware. The resultant system is to be used for highly reliable radar data and signal processing.

TVM Techno Venture Management
Provided consulting services to assist in assessing the technical claims of a company pursuing venture capital investment for a hardware implemented RAID 5 system .

Keyhold Engineering Inc., Northboro, MA.
Development of a prototype system for automatically calibrating multiple channel audio systems.

American Navigation Systems Inc., Milbury, MA.
Consulting on the development of the hand-held personal navigation and mapping system.

Lincoln Laboratory, Bedford, MA.
Simulated, tested and evaluated a GPS integrity monitoring algorithm developed at Lincoln Laboratories.

1.5 Licenses and Certifications

1.5.1 Commercial Radio Operator

General Radiotelephone Operator License
Ship RADAR endorsement

1.5.2 Amateur Radio Operator

Amateur Extra class radio operator license.

1.5.3 Diving Certifications

PADI Open Water Diver (ISO 24801-2 Diver Level 2 – Autonomous Diver)

2. Courses Taught at WPI

2.1 Course Descriptions

Short descriptions of the courses taught are as follows:

EE572N Advanced System Architecture

This course focuses on the architectural techniques used to achieve high-performance in SISD and SIMD computer systems. In this course the interaction between the software application and hardware architecture and the effect of this interaction on achievable performance is stressed. The course begins by covering the basic architectural tricks used to enhance system performance and ends with a series of case studies that analyze specific architectures such as the CRAY and CDC vector supercomputers, the MasPar, the Connection Machine, the ICL DAP, and others.

ECE505 Computer Architecture

This course is an introductory graduate course in computer architecture. Most aspects of CPU architecture are covered using a combined hardware/software approach. Specific topics include datapath design, memory systems, microprogramming, memory management, operating systems, and instruction set design.

ECE579M Real-Time System Design

This course focuses on the design of computer systems for which the timeliness of producing results is a critical factor for establishing the correctness of the system design. Topics covered include hardware specification, real-time operating systems and programming, scheduling, communications, and validation/verification. Issues and choices arising for single processor and distributed systems are also covered. Both hard and soft real-time system issues and the interactions between real applications and real systems is stressed.

ECE2010 Introduction to Electrical and Computer Engineering.

The objective of this course is to introduce students to the broad field of electrical and computer engineering within the context of real world applications. This course is designed for first-year students who are considering ECE as a possible major or for non-ECE students fulfilling an out-of-major degree requirement. The course will introduce basic electrical circuit theory as well as analog and digital signal processing methods currently used to solve a variety of engineering design problems in areas such as entertainment and networking media, robotics, renewable energy and biomedical applications. Laboratory experiments based on these applications are used to reinforce basic concepts and develop laboratory skills, as well as to provide system-level understanding. Circuit and system simulation analysis tools are also introduced and emphasized.

ECE2022 Introduction to Digital Circuits and Computer Engineering.

The objective of this course is to expose students (including first year students) to basic electrical and mathematical concepts that underlie computer engineering while continuing an introduction to basic concepts of circuits and systems in a hands-on environment. Experiments representing practical devices introduce basic electrical engineering concepts and skills which typify the study and practice of electrical and computer engineering. In the laboratory, the students construct, troubleshoot, and test analog and digital circuits that they have designed. They will also be introduced to the nature of the interface between hardware and software in a typical microprocessor based computer.

ECE2801 Foundations of Embedded Systems

This course teaches the principles of programming microprocessors and microcontrollers for real-time applications. Students are introduced to software engineering principles and are taught how to translate product specifications into engineering solutions.

ECE2799 ECE Design

This is a new course added to the curriculum that teaches sophomore Electrical Engineering students the basic principles of design. Topics are covered which range from project planning and management through manufacturing and implementation. Students are exposed to external factors influencing design such as safety, liability, cost, and other constraints.

ECE3801 Logic Circuits

This is an introductory course in logic circuit design. Topics covered include Boolean Logic, Algebraic minimization of logic equations, Karnaugh Maps, sequential machine design and timing analysis.

ECE3803 Introduction to Microprocessor Systems

This is an undergraduate-level first-course in microprocessor design. Topics covered include timing analysis, address decoding, memory system design, assembly language programming, programmed I/O, and digital/analog interfacing. Experiments are run using ISA-bus interfaces to standard PCs.

ECE3810 Advanced Digital System Design

This course addresses the design of advanced digital logic systems using VHDL to design, synthesize and model digital circuits, and to implement these circuits using Xilinx FPGA devices. The course emphasizes understanding functional design, designing for speed and power objectives, and testing. The course ends with students designing moderately complicated "system on a chip" (SOC) based systems

ECE4815 Computer Architecture (crosslisted as CS4515)

A first course in computer architecture. Essential aspects of CPU architecture are covered using a combined hardware/software approach. Students learn how a CPU interprets and processes instructions. Issues associated with interfacing hardware with software are covered in detail as are the hardware/software tradeoffs associated with performance optimization.

ECE4801 Microprocessor System Design

Microprocessor System Design is the second course in the microprocessor sequence. In this course, students learn the advanced concepts used in modern microprocessor systems. Topics such as system organization, dynamic and cache memory systems, communications, mixed language programming, and device driver design are covered.

ECE430X Fundamentals of Navigation Systems

This course introduces students to the fundamentals of navigation using electronic systems. The course covers types of navigation systems, how to interpret sensor data and sources of navigation system error. Topics include: types of navigation systems (dead reckoning, inertial, radio based systems), sensors and error sources, coordinate frames and transformations, system dynamics and measurement processing. Case studies explore the use of accelerometers, gyroscopes, GPS (including, differential and assisted GPS) as well as other types of navigation systems.

RBE 3001 Unified Robotics III

Third of a four-course sequence introducing foundational theory and practice of robotics engineering from the fields of computer science, electrical engineering and mechanical engineering. The focus of this course is actuator design, embedded computing and complex response processes. Concepts of dynamic response as relates to vibration and motion planning will be presented. The principles of operation and interface methods various actuators will be discussed, including pneumatic, magnetic, piezoelectric, linear, stepper, etc. Complex feedback mechanisms will be implemented using software executing in an embedded system. The necessary concepts for real-time processor programming, re-entrant code and interrupt signaling will be introduced. Laboratory sessions will culminate in the construction of a multi-module robotic system that exemplifies methods introduced during this course.

RBE 3002 Unified Robotics IV

Fourth of a four-course sequence introducing foundational theory and practice of robotics engineering from the fields of computer science, electrical engineering and mechanical engineering. The focus of this course is navigation, position estimation and communications. Concepts of dead reckoning, landmark updates, inertial sensors, vision and radio location will be explored. Control systems as applied to navigation will be presented. Communication, remote control and remote sensing for mobile robots and tele-robotic systems will be introduced. Wireless communications including wireless networks and typical local and wide area networking protocols will be discussed. Considerations will be discussed regarding operation in difficult environments such as underwater, aerospace, hazardous, etc. Laboratory sessions will be directed towards the solution of an open-ended problem over the course of the entire term.

RBE 400x Robot System Engineering and Design

The designers of robotic systems start with a system requirement to define the mechanical, electrical and software systems which must work together to achieve the system goals. Typically, parallel teams of engineers will work concurrently to create the requirements document as well as model various aspects of the system to verify operational capabilities and the ability to meet time and budget constraints. For complex systems, the development of such teams can itself be a complex problem since the project has to be organized in such a way that parallel teams can work independently, yet have excellent communication channels and information passing to insure project success.

This course explores the tools and techniques used to develop complex systems. The topics covered include: requirements development; system architecture and partitioning; requirements flowdown; functional and interface specifications; trade studies; system modeling and simulation; system integration; as well as design verification and validation.

RBE500 Foundations of Robotics

Foundations and principles of processing sensor information in robotic systems. Topics include an introduction to probabilistic concepts related to sensors, sensor signal processing, multi-sensor control systems and optimal estimation. The material presented will focus on the types of control problems encountered when a robot must operate in an environment where sensor noise and/or tracking errors are significant. Techniques for assessing the stability, controllability and expected accuracy of multi-sensor control and tracking systems will be presented. Lab projects will involve processing live and synthetic data, robot simulation and projects involving the control of robot platforms.

3. List of Publications:

3.1 Journal Papers

[1] T. Padir, W.R. Michalson, et. al., “Implementation of an Undergraduate Robotics Engineering Curriculum,” Computers in Education Journal, vol. I, no. 3, pp. 92-101, 2010.

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[4] I. F. Progri, W. R. Michalson, J. Wang and M.C. Bromberg, “Indoor Geolocation Using FCDMA Pseudolites: Signal Structure and Performance Analysis”, *NAVIGATION J. Inst. Nav*., Vol. 54, No. 3, Fall 2007.

[5] I. F. Progri, M. C. Bromberg and W. R. Michalson, “Maximum-Likelihood GPS Parameter Estimation”, *NAVIGATION J. Inst. Nav.*, vol. 52, no. 4, pp. 229-238, Winter, 2005-2006.

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[13] W. R. Michalson, “Auralization on a Laptop PC,” abstract appears in *The Journal of the Acoustical Society of America* , vol. 100 No. 4, Pt 2, pp. 2608, October 1996.

[14] R. H. Campbell, S. K. Martin, I. Schneider, and W. R. Michalson, “Analysis of Mosquito Wingbeat Sound,” *The Journal of the Acoustical Society of America* vol. 100 No. 4, Pt 2, pp. 2710, October 1996.

[15] W. R. Michalson, "Ensuring GPS Navigation Integrity using Receiver Autonomous Integrity Monitoring," *IEEE Aerospace and Electronic Systems Magazine*. vol. 10, no. 10, pp. 31-34, October 1995.

[16] S. Clayton, R. J. Duckworth, W. Michalson, A. Wilson, "Determining Update Latency Bounds in Galactica Net," *Concurrency: Practice, and Experience*, vol. 7, no. 7, pp. 595-611, October 1994.

3.2 Conference Papers

[1] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, “Using Both GPS L1 C/A and L1C: Strategies to Improve Acquisition Sensitivity,” Proc. 26th International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS 2013), Sep. 16-20, 2013.

[2] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, “Semi-Coherent and Differentially Coherent Integration for L1C Acquisition,” Proc. 2013 International Technical Meeting of the Institute of Navigation (ION ITM 2013), Honolulu, HI, Apr. 22-25, 2013.

[3] J.M. Barrett, M.G. Gennert, W. R. Michalson, et. al., “Development of a Low-Cost, Self-Contained, Combined Vision and Inertial Navigation System,” 2013 International Conference on Technologies for Practical Robotic Applications, Boston, MA Apr. 22-23, 2012.

[4] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, “Analysis of L1C Acquisition by Combining Pilot and Data Components Over Multiple Code Periods,” Proc. 2013 International Technical Meeting of the Institute of Navigation (ION ITM 2013), San Diego, CA, Jan. 28-30, 2013.

[5] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, “Analysis of Coherent Combining for L1C Acquisition,” Proc. 25th International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS 2012), pp.384-393, Nashville, TN, Sep. 17-21, 2012.

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[9] W.R. Michalson, S.J. Bitar and R.C.Labonte, “The Technical, Process, and Business Considerations For Engineering Design – A 10 Year Retrospective,” American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.

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[12] G. Tryggvason, W.R. Michalson, et. al., Teaching Multidisciplinary Design to Engineering Students: Robotics Capstone,” American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.

[13] A.C.Navalekar, W.R. Michalson, “Asymmetric throughput problem due to Push-to-talk (PTT) delays in CSMA/CA based heterogeneous Land Mobile Radio (LMR) networks”, accepted for publication, Milcom 2009.

[14] A. Navalekar and W.R. Michalson, "Effects of Unintentional Denial of Service (DOS) due to PTT delays on performance of CSMA/CA based Adhoc Land Mobile Radio (LMR) networks", accepted for publication, ICST Adhocnet 2009.

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[92] R. J. Duckworth, J. E. Lavallee, W. R. Michalson, L. Becker, and P. Green, "The Development of Intelligent Real-Time Systems Using Ada," *12th IEEE Symposium on Real-Time Systems*, Dec 3-6, 1991.

[93] W. Jessop, W. Michalson, and R. Some, "Fault Injection for Verifying Fault Tolerant System Behavior," *Workshop on Experimental Evaluation*, El Segundo, CA, May 1-3, 1990.

[94] W. R. Michalson and P. Heldt, "A Hybrid Architecture for the ART 2 Neural Model," *Proc. International Joint Conference on Neural Networks*, pp. 167-70, Washington D.C., Jan 15-19, 1990.

[95] W. R. Michalson, "A Review of the Current State of Logic Synthesis," *2nd Annual IEEE ASIC Seminar and Exhibit*, Rochester, NY, Sep 25- 28, 1989.

[96] P. E. Green and W. R. Michalson, "Real-Time Evidential Reasoning and Network Based Processing," *Proc. IEEE 1st International Conference on Neural Networks,* pp. 359-365, San Diego, CA, Jun 21-24, 1987.

[97] P. E. Green, R. J. Juels, and W. R. Michalson, "Real Time Artificial Intelligence Architecture," *Proc. Workshop on Future Directions in Computer Architecture and Software*, pp. 328-330, Charleston, SC, May 5-7, 1986.

3.3 Book Chapters

[1] W. Michalson and E. Schnieder, "An Approach for Implementing a Reconfigurable Optical Interconnection Network for Massively Parallel Computers," in *Optical Interconnection - Foundations and Approaches*, C. Tocci and H. J. Caulfield Eds., Artech House, proposed release January 1994.

3.4 Patents

Precision location methods and systems
United States Patent 8,928,459, Issued January 6, 2015

The invention describes systems and methods for determining the location of a transmitter by jointly and collectively processing the full sampled signal data from a plurality of receivers to form a single solution.

Apparatus and methods for addressable communication using voice-grade radios
United States Patent 8,284,711, Issued 9 October 2012
The invention relates to methods and apparatus for conducting directed communication using voice-grade radios. The methods and apparatus can be used to form a packet-switched wireless network using legacy analog transceivers, providing, e.g., both data and voice-over-Internet Protocol communication.

Multi-channel electrophysiologic signal data acquisition system on an integrated circuit.
United States Patent 7896807, issued 3 March 2011.
A physiologic data acquisition system includes an analog input, a sigma-delta front end signal conditioning circuit adapted to subtract out DC and low frequency interfering signals from and amplify the analog input before analog to digital conversion. The system can be programmed to acquire a selected physiologic signal, e.g., a physiologic signal characteristic of or originating from a particular biological tissue. The physiologic data acquisition system may include a network interface modulating a plurality of subcarriers with respective portions of an acquired physiologic signal. A receiver coupled to the network interface can receive physiologic data from, and send control signals and provide power to the physiologic data acquisition system over a single pair of wires. The network interface can modulate an RF carrier with the plurality of modulated subcarriers and transmit the resulting signal to the receiver across a wireless network. An integrated circuit may include the physiologic data acquisition system. Also included are methods for acquiring physiologic data comprising the step of selectively controlling an acquisition circuit to acquire the physiologic signal.

Methods and apparatus for high resolution positioning. United States Patent 7292189. The invention relates to a method of signal analysis that determines the location of a transmitter and to devices that implement the method. The method includes receiving by at least three receivers, from a transmitter, a first continuous-time signal having a first channel. The first channel includes a first plurality of signal carriers having known relative initial phases and having known frequencies which are periodically spaced and which are orthogonal to one another within a first frequency range. The signal analysis method also includes determining the phase shifts of the carriers of the first channel resulting from the distance the carriers traveled in reaching the first receiver. Analysis of the phase shifts yields time difference of arrival information amongst the receivers, which is further processed to determine the location of the transmitter. 6 Nov 2007.

A Reconfigurable Indoor Geolocation System, US Patent Number 7,079,025. A portable reconfigurable geolocation system is provided. The system includes a portable user node and one or more portable pseudolite nodes in communication one another and with the user node. Each of the user nodes and pseudolite nodes includes a transmitter that generates a signal on one or more carrier frequencies. Each signal is modulated with digital signals necessary to establish distances between the nodes and to convey data between the nodes. Each node also includes a receiver for receiving and demodulating the signals transmitted between the nodes, and a processor for receiving the demodulated signals, extracting data values and derived values from the demodulated signals and determining a three-dimensional position of each node in the system. Issued 18 Jul 2006.

Auto-Calibrating Surround System, United States Patent 7158643. A multi-channel surround sound system and method is described that allows automatic and independent calibration and adjustment of the frequency, amplitude and time response of each channel of the surround sound system. The disclosed auto-calibrating surround sound (ACSS) system includes a processor that generates a test signal represented by a temporal maximum length sequence (MLS) and supplies the test signal as part of an electric input signal to a loudspeaker. A microphone coupled to the processor receives the signal in a listening environment. The processor correlates the received sound signal with the test signal in the time domain and determines from the correlated signals a whitened response of the audio channel in the listening environment. Issued 2 Jan 2007.

Hand-held GPS-mapping device, US. Patent Number 5,987,380. A hand-held navigation, mapping and positioning device contains a GPS receiver, a database capable of storing vector or bit mapped graphics, a viewing port, an embedded processor, a simplified user interface, a data compression algorithm, and other supporting electronics, The viewport is configured such that the data presented in the viewport if clearly visible in any ambient light condition. The database stores compressed image data which might include topographical map data, user annotations, building plans, or any other image. The system includes an interface to a personal computer which may be used to annotate or edit graphic information externally to the device for later upload. In addition, the device contains a simple menu-driven user interface which allows panning and zooming the image data, marking locations of interest, and other such functions. The device may be operated from an internal rechargeable battery, or powered externally. , Issued 16 Nov 1999.

Hand-held GPS-mapping device, US. Patent Number 5,902,347. A hand-held navigation, mapping and positioning device contains a GPS receiver, a database capable of storing vector or bit mapped graphics, a viewing port, an embedded processor, a simplified user interface, a data compression algorithm, and other supporting electronics. The viewpoint is configured such that the data presented in the viewport is clearly visible in any ambient light condition. The database stores compressed image data which might include topographical map data, user annotations, building plans, or any other image. The system includes an interface to a personal computer which may be used to annotate or edit graphic information externally to the device for later upload. In addition, the device contains a simple menu-driven user interface which allows panning and zooming the image data, marking locations of interest, and other such functions. The device may be operated from an internal rechargeable battery, or powered externally. Issued 11 May 19/99.

3.5 Professional Presentations

American Ambulance Association Annual Meeting: Low-cost VHF/UHF Interoperability for digital telemetry, Las Vegas, NV, Dec. 2005.

California Ambulance Association, Keynote address: Alternatives to solving interoperability problems in Land Mobile Radios, Lake Tahoe, NV, July 2005.

Museum of Science Lecture Series: The Next Generation of Information and Communications Technologies-What does the Future Hold?, William R. Michalson and Brian King, January 14, 2004.

Agilent Wireless Technology Summit: Dynamic Node Location in an Ad Hoc Indoor Communications and Positioning Network, William R. Michalson, January 27, 2004

Security & Technology Online (SATO) Security Leadership Council. Panel discussion on Smart Surveillance, Command and Control, Oct 28-29, 2004.

"*Worcester Polytechnic Institute Barcelona Summit: The Future of Information Technology*," delivered presentation entitled "Personal Navigation in the Information Age," Apr 2001.

4. Projects advised (undergraduate).

4.1 Major Qualifying Projects (current)

[1] *Voice Release System,* B. Waldron, WZM-MQP-1M10, in process.

4.2 Major Qualifying Projects (completed)

[2] *Aeacus*, N. Anderson, D. Praetorius and C. Roddy, co-advised with S. Nestinger, 2011.

[3] *Realization of Performance Advancements for WPI's UGV-Prometheus*, M. Akmanalp, R. Doherty, J. Gorges, P. Kalauskas, E. Peterson and F. Polido, co-advised with T. Padir, S. Nestinger, M. Ciraldi, K. Stafford, 2011.

[4] *Autonomous Underwater Vehicle*, J. Baker, C. Frumento, J. Grzyb and T. North, co-advised w/I. Hussein, 2011.

[1] *Tactical Vest*, V. Brisian, J. Fernando, A. Khandaker and J. Zorrilla DeLos Santos, 2011.

[2] *Marsupial AUV*, N. Smith, B. Berard and C. Pietre, Lincoln Laboratory Project Center, co-advised with G. Heiniman, 2010.

[3] *Voice Release System,* J. Low, WZM-MQP-1M10, 2010.

[4] *Design and Realization of an Intelligent Unmanned Ground Vehicle*, J. Barrett, B. Roy and D. Sacco, Co-Advised w/T. Padir, 2010.

[5] *Accurate Real-Time Audio Circuit Simulation*, B. Gleason, WZM-MB09, 2010.

[6] *Optimization and Control Design of an Autonomous Underwater Vehicle*, D. Moussette, A. Palooparambil, and J. Raymond, AE- IIH-0003, co-advised w/I. Hussein, 2010.

[7] *Design of Autonomous Underwater Vehicle and Optimization of Hydrodynamic Properties and Control*, R. David, WZM-3A08, 2009.

[8] *Robotic Bass Player, B. Kosherick*, M. Brown, and A. Teti, WZM-RB08, 2008.

[9] *Public Safety Radio System*, P. Lucia, I. Levin and M. Barone, WZM-1A08, 2008.

[10] *Aircraft Lasercom Terminal Compact Optical Module*, B. Scoville and S. Rose, Lincoln Laboratory Project Center, WZM-2A08, 2008.

[11] *GPS Attitude Determination System*, J.P. Salmon, Michael LaBossiere and Mark Minotaur, 2005.

[12] *FPGA-Based VHF Modem With Integrated Testability*, Andrew Dupont and Jack Coyne, 2005.

[13] *TMR Computer System*, Maulin Patel, Omar Moussa and Matthew Kwiatkowski, 2005.

[14] *GPS Signal Generator*, Tim Coffey, 2005.

[15] *Dipole Antenna Placement in a Falcon-20 Aircraft*, Emily Anesta and David Plourde, Lincoln Laboratories Project Center, A-Term, 2004.

[16] *GPS Attitude Determination System*, Joshua Holwell, Himanshu Agrawal and Andrew Coonradt, 2004.

[17] *TMR Computer System*, Ryan Angilly, Mitch Lauer and Dan Debiasio, 2004.

[18] *Personal Inertial Navigation System*, Jason DeChiaro and Christopher Strus, 2003.

[19] WZM-MQP-4A02: *PC I/O in High Stress Environments*, John Niesz and James Kent, 2003.

[20] WZM-MQP-2A02: *Vacuum Tube Amplifier*, Joseph Kambourakis and Gregory Molnar, 2003.

[21] *Container Tracking System*, Victoria Chaplick, 2003.

[22] WZM-MQP-2A03: *Heat Management System for PCs*, Ernest Cardin, Kevin Candiloro and Stephen Leavey, 2002.

[23] WZM-MQP-1313: *Digital Image Enhancement*, Julie Bolduc, Joeseph Perry, Wei Fu, 2002.

[24] WZM-MQP-2A01: *Synchronized Audio Sample Looper*, Joel Gottshalk, Robert Conrad and Sanford Freedman, 2002.

[25] WZM-MQP-1A01: *Springboard Digital Multimeter*, Pavel Loven and Andrew Young, 2002.

[26] *Ballistic Missile Defense Analysis Toolkit*, Winfield Peterson, Doug Tilkin and Benjamin Wilson, Lincoln Laboratories Project Center, 2002.

[27] HU-FB-CS01, *C Sound Synthesizer*, Peter W. DeBonte (co-advised).

[28] WZM-MQP-1A00: *StrongArm-Based Computer System*, Bradford Snow, 2001.

[29] WZM-MQP-1C01: *PC Controlled Laser Light Show Device*, Joel Smith, 2001.

[30] WZM-MQP-1E00: *PIC-based MIDI Sequencer* Malcolm Beaulieu, 2001.

[31] WZM-MQP-2A00: *Automotive PC Development Platform* Travis Pouliot and David Philips, 2001.

[32] *The RoadCom Automotive Computing System*, Benjamin Kennedy and John Pong, 2000.

[33] WZM-MQP-1A99: *Compressed Sample Wavetable Synthesizer*, Justin Brzozoski, 2000.

[34] WZM-MQP-3499, *Automatically Equalizing Monitor*, Fernando Braghin, Tenzin Lama, Rahul Bhan and Dion Soetadi, 2000.

[35] 99D163M: *Railroad Communication*, Benjamin Richards, 2000.

[36] CS-MXC-IE00: *PIC Real-Time Sequencer*, Alexander Goodrich, 2000.

[37] 99D514M: *Design of a Microphone Preamplifier*, Eric Reuter, 2000.

[38] WZM-MQP-1A99, *MPEG Audio Deck*, Justin Brzozoski, 2000.

[39] *Digital Image Enhancement*, Julie Bolduc, Wei Fu and Joseph Perry, 2000.

[40] WZM-MQP-4A98, *Railroad Communications System*, Matthew Lug, 1999.

[41] 99D078M: *Modular Effects Processor II*, Erik Neyland, 1999.

[42] 99D176M: *Portable Digital Audio Recorder* Eric Toledo and Duc Truong, 1999.

[43] EE-WZM-1A97, *C Sound Synthesizer*, Ross E. Borgeson, Michael W. Hamel and Matthew S. Walsh, 1998.

[44] EE-WZM-4A97, *Firewire Audio Device*, Daniel R. Stutzbach, 1998.

[45] EE-WZM-2A97, *Modular Effects Processor*, Michael J. Dellisanti, 1998.

[46] EE-WZM-3A97, *GPS Personal Navigation*, Jeffery A. Alderson and Helder Machado, 1998.

[47] HU-FB-CS01, *C Sound Synthesizer*, Peter W. DeBonte (co-advised).

[48] EE-WZM-1E97, *PM Measurement System*, Yevgeniy Bogdanov.

[49] EE-REL-C008, *Design and Development of a Microprocessor-Based Gaussmeter*, David M. Burnham.

[50] EE-WZM-RC01, *Acoustic Guitar Amplifier*, Christopher Thomas.

[51] EE-WZM-GSD1, *Guitar Sustaining Device*, Paul D'Ambra.

[52] EE-RXV-5260, *Audio Feedback Elimination System*, Ross D. Pease and John R. Pelliccio.

[53] EE-RJD-M963, *Embedded Systems Design*, Christopher A. Briggs and Anthony J. Viapiano.

[54] EE-WHE-9601, *GPS Hazard Detector*, Michael Roberts, William Cidela, and Chris Mangiarelli.

[55] EE-WZM-2C96, *Flexible Synthesis*, Noah T. Vawter and Luke Demoracski.

[56] EE-WZM-1A96, *Tap Dancer MIDI Interface*, Thomas Trela and William Dowell.

[57] EE-WZM-2A96, *GPS Hazard Detector II*, Will Brothers, Jon Day, and John Zaghi.

[58] EE-WZM-3A96, *Loudspeaker Data Acquisition System*, Adam Gross.

[59] EE-WZM-4A96, *Audio Morphing Processor*, William Butterfield and Ted Phipps.

[60] EE-WZM-5A96, *Acoustic Modeling*, Peter DeBonte.

[61] EE-WZM-1B96, *Distributed Audio Controller*, Stephen S. Richardson.

[62] EE-WZM-1A95, *Acoustic Hazard Meter*, Ronald D. Slack.

[63] EE-WZM-2A95, *Forest Service DGPS*, Joshua J. Single and Michael T. Spadazzi.

[64] EE-WZM-1C95, *Audio to MIDI Converter*, Jennifer R. Principe.

[65] EE-WZM-1D95, *Low Cost Auralizer*, Jason R. Hills and Mark R. Paulson.

[66] EE-WZM-3A95, *Passive Radiator Design*, Kevin R. Weldon.

[67] EE-WZM-1C94, *Char Model Generation*, Colin J. Florendo.

[68] EE-WZM-1D94, *Wide Area DGPS Simulator*, Daniel Cohen and Robert Schroter.

[69] EE-WZM-2D94, *Digital Soundcard*, Timothy Alsberg (Russian Project Center).

[70] EE-WZM-3D94, *Digital Univibe*, Andrew Willis and Daniel Toohey.

[71] EE-WZM-1A94, *DSP Based Real-Time Audio Feedback Eliminator*, Kevin M. Eddy.

[72] EE-WZM-2A94, *Digital LCD Oscilloscope*, William F. Brown and John F. Ebersole.

[73] 93D236M, *MIDI Mapper*, Jonathan Kemble and Brian Candiloro.

[74] EE-WZM-1C93, *Fault-Tolerant Computer*, Frederick N. Parmenter.

[75] EE-WZM-1A93, *Wireless MIDI Controller*, Sanjay Raja, Charles Cimalore, Ty Panagoplos.

[76] EE-WZM-2A93, *Multiple Pitch Detector*, Jeanne A. Sawtelle.

[77] EE-WZM-3A93, *Multiprocessor Cache Coherence*, Lauren C. Lind and Norman E. Rhodes.

[78] EE-WZM-1C92, *A Simulation of the DLX Architecture*, Lisa Harlow.

[79] EE-WZM-2C92, *A New Microprocessor Development System*, Gregory B. Burlingame, David J. Fortin, Kevin S. Pearson.

[80] EE-WZM-1A92, *Digital Audio Sampler*, Roger D. Gagnon and James M. Lach.

[81] EE-WZM-2A92, *Intelligent Harmonizer*, Prabhjot S. Anand and Aftab M. Yusuf.

[82] EE-WZM-3A92, *Computerized Audio Mixer*, Richard J. Wood.

[83] EE-WZM-1B92, *Real-Time Harmonizer*, Mohiuddin M. Kahn.

[84] EE-WZM-1A91, *Residue Number System Processor*, Ravdeep S. Anand and Christine A. Easton.

[85] EE-WZM-2A91, *SCSI Bus Analyzer*, Brian Costello, George Delouriero, Matthew Maguire, and Keith Nevins.

4.3 Graduate Theses Advised and Co-Advised

4.3.1 MS Theses (current)

[1] No Current MS Students

4.3.2 MS Theses (completed)

[1] Morin, Russell, "A Novel Localization System For Experimental Autonomous Underwater Vehicles," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2010.

[2] Navalekar, Abhijit, "Design of an OFDM-Based VHF Modem," MS Thesis, primary advisor, Worcester Polytechnic Institute.

[3] Ahlehagh, Hasti, "Techniques for Communications and Geolocation Using Wireless Ad Hoc Networks," MS Thesis, primary advisor, Worcester Polytechnic Institute, 2004.

[4] Sebastian, Dalys, "Development of a Field-Deployable Ultrasound Scanner System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2004.

[5] Tobgay, Sonam, "Novel Concepts for RF Surface Coils with Integrated Receivers," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2004.

[6] Breen, Daniel, "Characterization of Multi-Carrier Locator Performance," MS Thesis, co-advisor, 2004.

[7] Aghogho, Obi, "A Novel Radio Frequency Coil Design for Breast Cancer Screening in a Magnetic Resonance Imaging System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2003.

[8] Fei, Ming, "Electromagnetic Detection, Infrared Visualization and Image Processing Techniques for Non-Metallic Inclusions in Molten Aluminum," MS Thesis, co-advisor, 2002.

[9] Lavoie, Bruce, "Design and Implementation of an N-Channel Self Calibrating Audio System," MS Thesis, primary advisor, Worcester Polytechnic Institute, 2000.

[10] Bogdonov, Gene, "Theoretical and Practical Implementation of Electrical Impedance Material Inspection of Powder Metallurgy Compacts," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1999.

[11] Messier, Andrew, "Modeling the Effects of Terrain Masking on GPS Accuracy and Integrity," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1998.

[12] Antonescu, Bogdan, "Elliptic Curve Cryptosystems on Embedded Microprocessors," Bogdan Antonescu, MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.

[13] Lai, Qiang, "Ground-Penetrating Radar Data Processing System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.

[14] Soria-Rodríguez, Pedro, "Multicast-Based Interactive-Group Object-Replication For Fault Tolerance," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.

[15] Hoy, William, “Audio Signal Denoising Using Wavelets,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 1997.

[16] Progri, Ilir, “Harmonic Flow Monitoring by means of Global Positioning System,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 1997.

[17] Bretchko, Pavel, “Pulsed Hysteresis Graph System,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 1997.

[18] Repkin, Dmitry V., “A Hierarchical Neural Network Based Data Processing System for Ground Penetrating Radar,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 1997.

[19] Metsis, Sophocles, “Design of a Real-Time Capable, Fault-Tolerant, Distributed System,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 1996.

[20] Hill, Jonathan, “Efficient Implementation of Mesh Generation and FDTD Simulation of Electromagnetic Fields,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 1996.

[21] Dunkelberg, John, “FEM Mesh Mapping to a SIMD Machine Using Genetic Algorithms,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 1996.

[22] Leuenberger, Georg, “Design and Development of a Microprocessor Based Gauss Meter,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 1995.

[23] Valentino, Ralph, “DISC: A Dynamic Instruction Set Coprocessor,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 1995.

[24] Muley, Aalok, “A Fault Tolerant Network for a Real-Time Environment,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 1994.

[25] Mohan, Surrender, “Automatic Surface Mesh Generation for 3D Solid Models Using Delaunay Algorithm,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 1994.

[26] Petrangelo, John, “Experimental Preconditioners for Large Dense Systems,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 1994.

[27] Schneider, Eric, “Design, Simulation, and Analysis of a 3D Integrated Optical Computer,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 1993.

[28] Palmer, Bradley, “A Comparison of Three Protocols Supporting Time-Dependent and Time-Independent Communications,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.

[29] Clayton, Shawn, “An Analysis of the Real-Time Behavior of Galactica Net,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.

[30] Levergood, Thomas, “An Experimental Evaluation of Split User/Supervisor Cache Memories,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.

[31] Lavalee, James, “The Design and Development of Real-Time Systems Using Ada and the Activation Framework,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 1992.

[32] Velazques, Javier, “The Development of a Real-Time Environment Using the Activation Framework,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 1992.

4.3.3 Ph. D. Dissertations (current)

[1] Jitesh, "Ad-Hoc Networking for Bandwith Limited LMR Systems," primary advisor.

4.3.4 Ph. D. Dissertations (completed)

[1] Iyer, Vishwanath, "Broadband Impedance Matching of Antenna Radiators," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2010.

[2] Navalekar, Abhijit, "Distributed Digital Radios For Land Mobile Radio Applications," Ph.D. Dissertation, primary advisor, Worcester Polytechnic Institute, 2009.

[3] Parikh, Hemish, "Design of an OFDM Transmitter and Receiver for Precision Personnel Location," primary advisor.

[4] Progri, Ilir, "An Assessment of Indoor Geolocation Systems," Ph.D. Dissertation, primary advisor, Worcester Polytechnic Institute, 2003.

[5] Li, Xinrong, "Super-Resolution TOA Estimation with Diversity Techniques for Indoor Applications," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2003.

[6] Leuenberger, Gerog H. W., "Electrostatic Density Measurements in Green-State PM Parts," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2003.

[7] Bogdanov, Gene, "Radio-Frequency Coil Design for High Field Magnetic Resonance Imaging," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2002.

[8] Elbirt, Adam J., "Reconfigurable Computing for Symmetric-Key Algorithms," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2002.

[9] Bretchko, Pavel, "Design and Development of Ultra-wideband DC-Coupled Amplifier," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2001.

[10] Hill, Jonathan, "Development of an Experimental Global Positioning System (GPS) Receiver Platform for Navigation Algorithm Evaluation," Ph.D. Dissertation, primary advisor, 2001.

[11] Spasojević, Mirko, "Creation of Sparse Boundary Element Matricies for 2-D and Axi-symmetric Electrostatic Problems Using a Bi-orthogonal Wavelet," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 1997.

[12] Shi, Funan, "Optimal Designs of Gradient and RF Coils for Magnetic Resonance Imaging (MRI) Instrument," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 1996.

5. Proposals and Funding (past 5 years):

5.1 In Review

$ 199,996 A National Model Robotics Curriculum, NSF (PI: Dr. M. Gennert, Co-PIs: Drs. T. Padir, W.R. Michalson, G. Fischer and C. Demetry), May 2009.

$ 199,052 A National Model Robotics Capstone, NSF (PI: Dr. W.R. Michalson, Co-PIs: Drs.T. Padir, C. Demetry, G. Tryggvason and F. Looft), May 2009.

$ 399,791 Modular System for Teaching Robotics Engineering (MySTRE), NSF (PI: Dr. G. Fischer, Co-PIs: Drs. W.R. Michalson and T. Padir), March 2009.

5.2 Funding Received

$ 50,524 PCGO Broadband Modem, Powerwave Technologies, Inc., (PI: Dr. W.R. Michalson), May 2009.

$ 1,245,000 Real-Time Troop Status Monitoring System, US Army Telemedicine and Advanced Technology Research Center. (PI: Dr. Peder Pedersen, Co-PIs: Drs. William R. Michalson and Yitzhak Mendelson). Third year of funding. Projected funding period: Oct 1, 2004 to Sep 30, 2005.

$ 148,422 Precision Personnel Locator System, National Institute of Justice (PI: Dr. John Orr, Co-PIs: Drs. David Cyganski and William R. Michalson). Second year of funding. Projected funding period: Sep 1, 2004 to Oct 31, 2005. Grant code 219240.

$ 74,048 High-Speed VHF Modem, US Army Telemedicine and Advanced Technology Research Center (PI: Dr. William R. Michalson). Funding period: Mar 1, 2004 to Dec 31, 2004. Grant code 214370.

$ 81,499 WPI Nanosat Program, Air Force Office of Scientific Research (PI: Dr. Fred Looft, Co-PIs: Drs. William R. Michalson and Diran Apelian). Funding period: Apr 1, 2003 to Mar 31, 2005. Grant code 214400.

$ 996,000 Precision Personnel Locator System, National Institute of Justice (PI: Dr. David Cyganski, Co-PIs: Drs. William R. Michalson and John Orr). Second year of funding. Projected funding period: Sep 1, 2004 to Aug 31, 2005. Grant code 219240.

$ 813,141 Real-Time Troop Status Monitoring System, US Army Telemedicine and Advanced Technology Research Center, (PI: Dr. William R. Michalson, Co-PIs: Drs. Peder Pedersen and Yitzhak Mendelson). Second year of funding. Funding period Oct 1, 2003 to Sep 30, 2004. Grant code 214370.

6. Honors, Awards, and Recognitions:

Elected Senior Member of the IEEE.

Joseph Samuel Satin Distinguished Fellowship awarded for the 1994-1995 academic year.

Aldo Miccioli Fellowship recipient from Raytheon Equipment Division.

ION Best Paper Award - GPS-96 for W. R. Michalson, W. Cidela, et. al., “A GPS-Based Hazard Detection and Warning System,” in review, " *ION GPS-96, 9th International Meeting of the Satellite Division of the Institute of Navigation*, pp. 167-175, Kansas City, MO, Sep 17-20, 1996

2nd Place - 2004 ECE Department MQP Award / Provost's MQP Award for *GPS-Based Orbit and Attitude Determination System for PANSAT*, Joshua Holwell, Andrew Coonradt and Himanshu Agrawal.

1st Place - 2003 ECE Department MQP Award / Provost's MQP Award for *Personal Inertial Navigation System*, Jason DeChiaro and Chris Struus.

1st Place - 2002 ECE Department MQP Award / Provost's MQP Award for *Handspring Digital Voltmeter*, Andrew Young and Pavel Loven.

3rd Place - 1998 ECE Department MQP Award / Provost's MQP Award for *Design of a Personal Handheld GPS Receiver*, Jeffery Alderson and Helder Machado.

2nd Place - 1997 ECE Department MQP Award / Provost's MQP Award for *Distributed Audio Controller*, EE-WZM-1B96, Stephen S. Richardson.

3rd Place - 1997 ECE Department MQP Award / Provost's MQP Award for *GPS Hazard Detector II*, EE-WZM-2A96, Will Brothers, Jon Day, and John Zaghi.

1st Place - 1996 ECE Department MQP Award / Provost's MQP Award for *GPS Hazard Detector*, EE-WHE-9601, Michael Roberts, William Cidela, and Chris Mangiarelli.

6.1 Memberships and offices held in professional society

Institute of Electrical and Electronic Engineers, Senior Member

Institute of Navigation

Royal Institute of Navigation

American Society of Engineering Educators

6.2 Professional Service

Massachusetts Board of Bar Overseers Hearing Committee Member, 2010-Present.

Steering Committee – 2009 First Annual Robotics Innovations Competition and Conference (RICC '09), Nov 7-8, Worcester, MA, 2009.

Conference Technical Co-Chair – 2009 IEEE International Conference on Technologies of Practical Robot Applications (TePRA 2009), Nov. 9-11, Woburn, MA, 2009.

Reviewer – Proposal number CRDPJ 379622-08, Natural Sciences and Engineering Research Council of Canada (NSERC), Mar. 2009

Co-Chair – Urban and Indoor Geolocation, Institute of Navigation International Technical Meeting (ITM2009), Anaheim CA, Jan. 2009.

Reviewer – Proposal number CRDPJ 379622-08, Natural Sciences and Engineering Research Council of Canada (NSERC), Mar. 2009