

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NATIONAL RAILROAD PASSENGER CORPORATION D/B/A AMTRAK
Petitioner

v.

RAILWARE, INC.
Patent Owner

U.S. Patent No. 9,517,782
Issue Date: December 13, 2016
Title: TOOLS FOR RAILWAY TRAFFIC CONTROL

Inter Partes Review No. IPR2023-01179

**DECLARATION OF DR. WILLIAM R. MICHALSON
IN SUPPORT OF PETITION
FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 9,517,782
CHALLENGING CLAIMS 1-8**

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I, William R. Michalson of Douglas, Massachusetts, declare that:

I. ASSIGNMENT

1. I have personal knowledge of the facts stated herein, and if called upon to testify to those facts I could and would competently do so.

2. I have been retained by Venable LLP, counsel for National Railroad Passenger Corporation d/b/a Amtrak (“Amtrak”), to provide my technical opinions related to U.S. Patent No. 9,517,782 (“’782 Patent”) (EX1001).

3. I understand that Amtrak is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) to institute an *inter partes* review (“IPR”) proceeding of the ’782 Patent.

4. I have been asked to provide my independent analysis of the ’782 Patent based on the prior art cited in this declaration.

5. I am not and never have been, an employee of Amtrak.

6. I am being compensated for my time at my standard hourly consulting rate of \$525 per hour. My compensation does not depend on the outcome of this matter or the specifics of my testimony. I have no financial interest in the outcome of this matter.

7. In forming my opinions expressed in this declaration, I have relied on my extensive knowledge, training, and experience, as well as the materials cited herein.

II. QUALIFICATIONS

8. I am over the age of 18 and am competent to write this declaration. I have personal knowledge, or have developed knowledge of these technologies based upon education, training, or experience, of the matters set forth herein.

9. I earned a B.S. from the Syracuse University in 1981, an M.S. and a Ph.D. in Electrical Engineering from the Worcester Polytechnic Institute (“WPI”) in 1985 and 1989, respectively.

10. I am currently a tenured Professor of Robotics Engineering in the Robotics Engineering Department of WPI. Additionally, I have appointments as a Professor of Computer Science, Electrical and Computer Engineering, and Mechanical Engineering. At WPI, I perform research and teach in the areas of navigation, communications, and computer system design. I supervised the WPI Center for Advanced Integrated Radio Navigation (“CAIRN”), where I was developing a Public Safety Integration Center focused on the integration of communications, navigation, and information technologies for public safety applications. Currently I direct the Robot Communication and Navigation

Laboratory where my research focuses on the development, testing, and evaluation of communication and navigation systems for both civilian and military applications with a special emphasis on techniques focused on indoor, underground, or otherwise GPS-deprived situations. My interests in communication, navigation, and computing have led me to play an active role in the development of the Robotics Program at WPI, where I teach robotics courses at the graduate and undergraduate level.

11. Prior to joining the faculty of WPI, I worked at the Raytheon Company from 1981-1991, with a leave of absence between 1985-1988 to complete my Doctoral Degree (Ph.D.) in Electrical Engineering from the Worcester Polytechnic Institute. Prior to my leave of absence, I worked as an Engineer in the Cursive Displays Department and VLSI Design Department of the Computer and Displays Laboratory within Raytheon's Equipment Division. After receiving my Ph.D., I returned to the Equipment Division of the Raytheon Company where I was promoted to a title of Engineer, Design and Development. I was subsequently selected to sit on the engineering staff of the newly-formed System Engineering Department of the Division's Computer and Displays Laboratory. In this capacity, I acted primarily as a consultant to other departments within the laboratory, and my responsibilities ranged from leading the hardware and software development of supercomputer-class

computer systems to performing applied research into the exploitation of new technology.

12. I have more than 40 years of experience in the field of computer technology, specifically in the specialized field of signal and data processing. I have consulted and served, including being qualified by courts, as an expert for numerous patent cases, including in patent cases involving motion sensing, positioning, map navigation technologies, and wireless communications a listing of which is set forth in my current curriculum vitae which is attached to this Declaration as Appendix A. I hold a commercial General Radio Operator's license (with Ship RADAR Endorsement), an Extra Class Amateur Radio operator's license, and have held a Commercial Radiotelegraph Operators license. I was first licensed as a Radio Amateur in 1974 and have been involved in the design, implementation, and repair of radio systems, including radio-controlled systems, since that time.

13. I have been involved with numerous projects involving the tracking and control of remote objects, including flying objects. Starting with my work at Raytheon Company I was involved with the tracking of aircraft in both military and civilian air traffic control systems. I have worked on the guidance and control systems for multiple missile systems as well as the guidance and tracking systems for fire control systems and on spaceborne systems for tracking ballistic missiles. In

my work at WPI, I have been involved with numerous projects related to tracking land, sea, and air vehicles using the GPS and/or inertial guidance systems. Some of this work has involved the use and control of rotorcraft for applications, such as firefighting and landmine detection and destruction.

14. I am a named inventor on nine patents, including patents on map navigation devices, geolocation systems, and high resolution and precision location systems. I have authored, or co-authored, over 100 journal papers and conference publications, including papers and publications regarding positioning and navigation systems and methods. I am also the co-author of a chapter entitled “An Approach for Implementing a Reconfigurable Optical Interconnection Network for Massively Parallel Computers” in Optical Interconnection – Foundations and Approaches by C. Tocci and H. J. Caulfield Eds., Artech House, 1994. I am currently under contract to write a book tentatively entitled “Radionavigation and the Global Positioning System,” which covers the physical principles upon which radionavigation system are based as well as the hardware and software required to perform navigation. At WPI I have taught courses in Sensors, Circuits, and Systems, Digital Circuit Design, Embedded Computing, Computer Architecture, Computer, and Navigation. In addition, I have advised projects involving computer systems, navigation, and communications for a large variety of applications in the air, on land, and on the sea.

15. Additionally, I have worked specifically with railway safety systems and communications. In the mid 1990s I worked on several projects sponsored by the Providence & Worcester Railroad that focused on alerting engineers on freight trains if switches along the track were in the correct position as they approached. Historically, engineers would look for a reflector on a switch to verify its position, however that procedure was unreliable depending on weather and other factors. The system developed had a unit mounted in the locomotive that tracked train position and contained a database of switch locations. As the train approached a switch a radio signal was sent to the switch to verify switch position. If the switch was in the correct position, the engineer was given a “green light” allowing him to proceed. Otherwise, a “red light” signal and an annunciator were used to notify the engineer of the problem.

16. This system, featured in the Discover Magazine show #310 “Fatal Flaws,” had three main parts. The first was a unit on the locomotive containing a processor, memory, GPS receiver, radio, packet modem, and user interface. The second part was a switch unit that mounted to a pole at the switch location which contained a processor, memory, GPS receiver, radio, packet modem, and a connection to an electrical interface on the rail switch. The last part was a

programming unit that allowed capturing the GPS location of a switch unit and transferring it to the unit on the locomotive.

17. I have received numerous awards and recognition for my work, including becoming an Elected Senior Member of the IEEE. In addition, I was awarded the Joseph Samuel Satin Distinguished Fellowship for the 1994-1995 academic year, and the Aldo Miccioli Fellowship from the Raytheon Company's Equipment Division. I am also a member of the Institute of Navigation, the Royal Institute of Navigation, the American Society of Engineering Educators, The Society of Automotive Engineers, the National Marine Electronics Association, and the National Academy of Inventors.

18. My curriculum vitae, attached as Exhibit A, includes a list of publications on which I am a named author. It contains further details regarding my experience, education, publications, and other qualifications provide to an expert opinion in connection with this proceeding.

III. SUMMARY OF CONCLUSIONS FORMED

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

20. **Ground 1:** Based upon my knowledge and experience, I believe that claims 1-8 of the '782 Patent are made obvious by Oriol.

21. **Ground 2:** Based upon my knowledge and experience, I believe that claims 1-8 of the '782 Patent are made obvious by Oriol and Masquelier.

22. **Ground 3:** Based upon my knowledge and experience, I believe that claims 1-8 of the '782 Patent are made obvious by Oriol and Wise.

23. **Ground 4:** Based upon my knowledge and experience, I believe that claims 1-8 of the '782 Patent are made obvious by Oriol, Masquelier, and Wise.

24. **Ground 5:** Based upon my knowledge and experience, I believe that claims 1-8 of the '782 Patent are made obvious by Oriol, Masquelier, and Pachl.

25. **Ground 6:** Based upon my knowledge and experience, I believe that claims 1-8 of the '782 Patent are made obvious by Tamaribuchi and Pachl.

26. **Ground 7:** Based upon my knowledge and experience, I believe that claims 1-8 of the '782 Patent are made obvious by Wise and Masquelier.

IV. LEVEL OF ORDINARY SKILL IN THE ART

27. I have been informed that a person of ordinary skill in the art ("POSITA") is a hypothetical person who is presumed to have the skill and experience of an ordinary worker in the field at the time of the alleged invention.

28. I believe a POSITA as of the Priority Date (discussed below) would have had at least a bachelor's degree in electrical, mechanical, or related engineering, and also would have had at least two (2) years of experience in railway operations

or railway control systems and would have programming experience. A higher level of education or specific skill might make up for less experience, and vice-versa.

29. I have more than ordinary skill in the art based on my Ph.D. in Electrical Engineering, four (4) years of experience working with railway systems, and decades of experience working with highly-reliable, safety-critical, hardware and software systems.

V. LEGAL PRINCIPLES

30. I am not a lawyer and I will not provide any legal opinions in this IPR declaration. Although not a lawyer, I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.

A. Claim Interpretation

31. I understand that claim terms are generally given their plain and ordinary meaning based on the patent's specification and file history as understood by a person of ordinary skill in the art at the time of the purported invention. In that regard, I understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by a POSITA. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination

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

B. Priority

32. I understand that a continuation application is a later-filed application that has the same disclosure (specification and figures) as an earlier filed application to which the later-filed application claims priority. A continuation is generally entitled to the same priority date as the later-filed application to which it claims priority.

C. Obviousness

33. I understand that a patent claim is invalid if the claimed invention would have been obvious to a person of ordinary skill in the field at the time of the purported invention, which is often considered the time the application was filed. Even if all of the claim limitations are not found in a single prior art reference that anticipates the claim, the claim can still be invalid.

34. To obtain a patent, a claimed invention must have, as of the priority date, been nonobvious in view of the prior art in the field. I understand that an invention is obvious when the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have

been obvious at the time the invention was made to a person having ordinary skill in the art.

35. I understand that, to prove that prior art or a combination of prior art makes a patent obvious it is necessary to: (1) identify the particular references that, singly or in combination, make the patent obvious; (2) specifically identify which elements of the patent claim appear in each of the asserted references; and (3) explain a motivation, teaching, need, market pressure or other legitimate reason that would have inspired a person of ordinary skill in the art to combine prior art references to solve a problem.

36. I also understand that certain objective indicia can be important evidence regarding whether a patent is obvious or nonobvious. Such indicia include:

- Commercial success of products covered by the patent claims;
- A long-felt need for the invention;
- Failed attempts by others to make the invention;
- Copying of the invention by others in the field;
- Unexpected results achieved by the invention as compared to the closest prior art;
- Praise of the invention by the infringer or others in the field;
- The taking of licenses under the patent by others;

- Expressions of surprise by experts and those skilled in the art at the making of the invention; and
- The patentee proceeded contrary to the accepted wisdom of the prior art.

37. To the extent these factors have been brought to my attention, if at all, I have taken them into consideration in providing my opinions and conclusions.

VI. MATERIALS CONSIDERED

38. My analysis and conclusions set forth in this declaration are based on my educational background and experiences in the field (*see* Section II). Based on my knowledge and experience, I believe that I am considered to be an expert in the field. Also, based on my knowledge and experience, I understand and know of the capabilities of persons of ordinary skill in the field during before the Priority Date.

39. As part of my independent analysis for this declaration, I have considered the following: the background knowledge/technologies that were commonly known to persons of ordinary skill in this art during the time before the earliest claimed priority date for the '782 Patent; my own knowledge and experiences gained from my work experience in the field of the '782 Patent and related disciplines; and my experience in working with others involved in this field and related disciplines.

40. In addition, I have analyzed the following publications and materials:

- U.S. Patent No. 9,517,782 (the “782 Patent”) (EX1001)
- File History of U.S. Patent No. 9,517,782 (EX1002)
- Oriol, N., Sheridan, T. and Multer, J. (2004). Supporting Railroad Roadway Worker Communications with a Wireless Handheld Computer: Volume 1: Usability for the Roadway Worker. Report No. DOT/FRA/ORD-04/13.i. U.S. Department of Transportation, Federal Railroad Administration (“Oriol”) (EX1004)
- Masquelier, T., Sheridan, T., and Multer, J. (2004). Supporting Railroad Roadway Worker Communications with a Wireless Handheld Computer: Volume 2: Impact on Dispatcher Performance. Report No. DOT/FRA/ORD-04/13.ii. U.S. Department of Transportation, Federal Railroad Administration (“Masquelier”) (EX1005)
- WO International Publication No. 2004/042663 to Wise (“Wise”) (EX1006)
- U.S. Patent Application Pub. No. 2012/0176217 to Tamaribuchi et al. (“Tamaribuchi”) (EX1007)

- Railware, Inc. v. National Railroad Passenger Corporation d/b/a/ Amtrak, 1:22-cv-5013-KPF, Amended Complaint, Dkt. No. 27 (Jun. 30, 2022 S.D.N.Y.) (EX1011)
- Federal Railroad Administration, Research Reports, available at <https://web.archive.org/web/20050211025837/http://www.fra.dot.gov/ov/us/content/412> (Feb. 2005) (EX1013)
- Federal Railroad Administration, Research Reports, available at <https://web.archive.org/web/20060922194521/http://www.fra.dot.gov/ov/us/content/412> (Sept. 2006) (EX1014)
- Federal Railroad Administration, Research Reports, available at <https://web.archive.org/web/20080212192107/http://www.fra.dot.gov/ov/us/content/412> (Feb. 2008) (EX1015)
- Federal Railroad Administration, Research Reports, available at <https://web.archive.org/web/20090320043352/http://www.fra.dot.gov/ov/us/content/412> (Mar. 2009) (EX1016)
- GB2366419 to Nagai et al. (“Nagai”) (EX1017)
- WO International Publication No. 2005/047074 to Makkinga (“Makkinga”) (EX1018)
- U.S. Patent No. 6,959,233 to Hungate et al. (“Hungate”) (EX1019)

- U.S. Patent No. 7,328,090 to Pachl (“Pachl”) (EX1020)
- U.S. Patent No. 8,406,943 to Brand et al. (“Brand”) (EX1021)
- Internet Archive Affidavit for URLs in EX1013-1016 (EX1022)
- Excerpt of File History from U.S. Patent RE49115 (EX1023)
- U.S. Patent No. 9,403,545 to Pirtle (the “’545 Patent”)
- File History of U.S. Patent No. 9,403,545
- U.S. Provisional Application no. 61/893,547 to Pirtle
- U.S. Patent RE47835 (the “RE’835 Patent”)
- File History of U.S. Pat. RE47835
- U.S. Patent RE49115 (the “RE’115 Patent”)
- File History of U.S. Patent RE49115
- Malsch, N., Sheridan, T. and Multer, J. (2004). *Impact of Data Link Technology on Railroad Dispatcher Operations*. Report No. DOT/FRA/ORD-04/11. U.S. Department of Transportation, Federal Railroad Administration (“Malsch”)

41. My analysis and conclusions set forth in this declaration are based on the perspective of a POSITA.

VII. TECHNOLOGY OVERVIEW

42. The '782 Patent acknowledges that it was known to use “centralized traffic control” to govern interlocking signals for track blocking and unblocking (EX1001, 1:25-47; EX1011, ¶ 14) and was known that “[i]nformation regarding track conditions . . . is presented on a control console,” which controls “each interlock signal (that is, the dispatcher controls the train traffic and flow of train traffic using the interlocks). . . .” EX1001, 1:48-2:3.

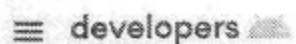
43. Before the Priority Date, it was conventional for railway workers to operate a mobile device for communicating with a central control system (dispatcher) to block and unblock a track. EX1018, Abstract, 8:5-14, 10:7-10, 11:9-17; EX1017, Abstract, Figs. 10-11.

44. It was also known to generate and communicate a code to authorize train movement. EX1019, Abstract, 1:12-16, 4:35-42; EX1021, Abstract, Fig. 4.

45. The named inventor acknowledged to the USPTO in the application leading to RE'115 Patent that mobile phones, text messaging, and email were conventional before the Priority Date and thus indicated that these known communication methods could be applied to railway systems. EX1023, 8 (¶¶ 5-7), 15-16.

46. This acknowledgement is shown below in a document provided by Mr. Pirtle to the USPTO.

<https://android-developers.googleblog.com/2010/03/speech-input-api-for-android.html>



Android Developers Blog

The latest Android and Google Play news for app and game developers.

Speech Input API for Android

05 March 2010

People love their mobile phones because they can stay in touch wherever they are. That means not just talking, but e-mailing, texting, microblogging, and so on. So, in addition to search by voice and voice shortcuts like "Navigate to", we included a voice-enabled keyboard in Android 2.1, which makes it even easier to stay connected. Now you can dictate your message instead of typing it. Just tap the new microphone button on the keyboard, and you can speak just about anywhere you would normally type.

Id., 15 (excerpt); *id.*, 2.

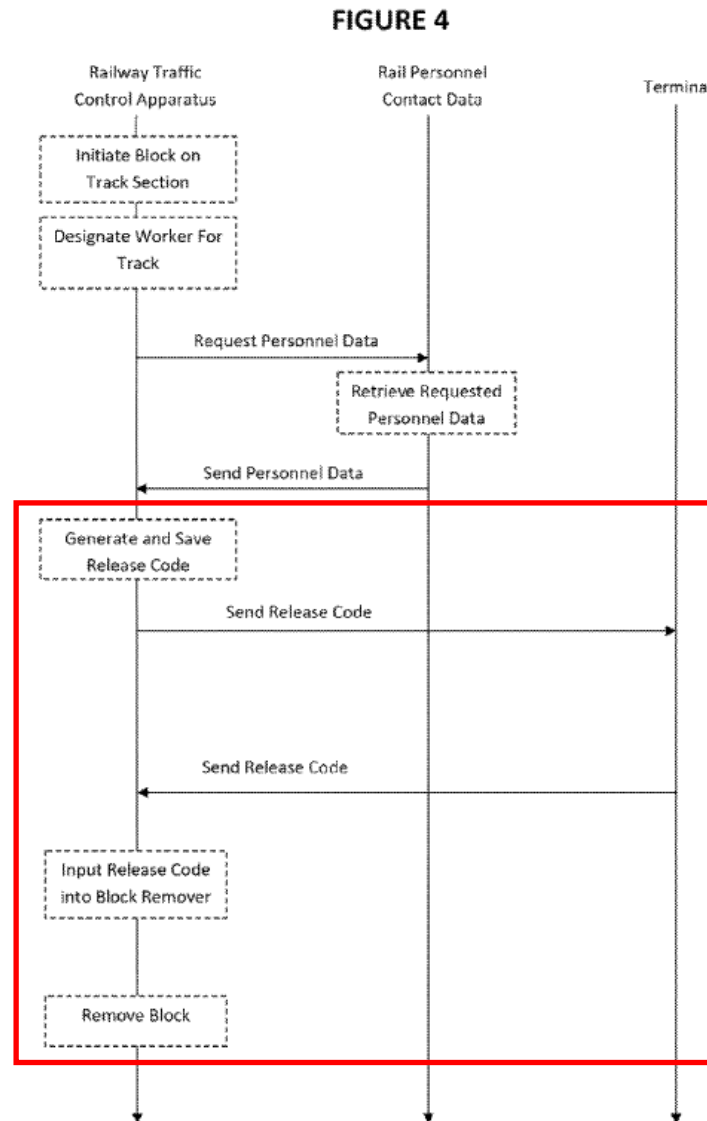
VIII. OVERVIEW OF THE '782 PATENT

A. Specification

47. The '782 Patent (having application no. 15/177,506) was filed on June 9, 2016, claiming alleged priority to application no. 14/519,727 (now U.S. Patent No. 9,403,545) filed on October 21, 2014, and provisional application no. 61/893,547 filed on October 21, 2013. EX1001, front page; EX1002, 2.

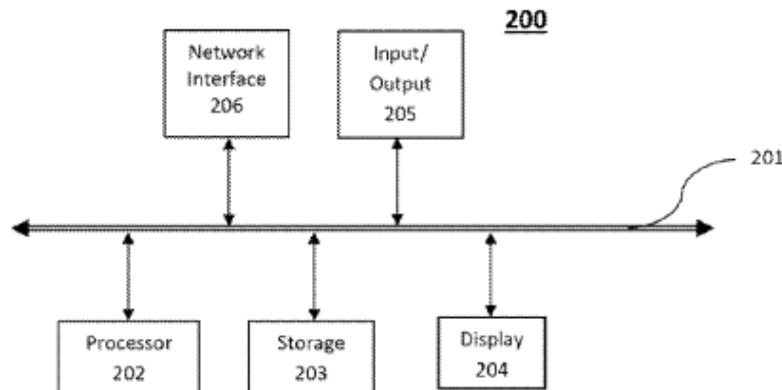
48. The '782 Patent describes "[t]ools . . . to control traffic over a railway track section . . . [and] when traffic over the track section is to be blocked, a release

code is generated and sent to . . . the railway worker. Traffic through the track section is blocked until the release code is entered in the system.” EX1001, Abstract, 2:53-58 (similar). This is shown in Figure 4 below.



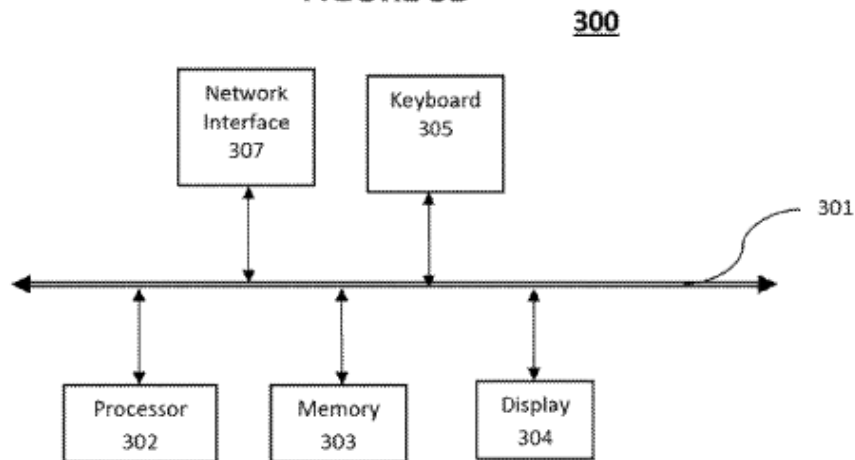
Id., Fig. 4 (annotated). The specification admits it invokes generic hardware, as shown in Figures 3A (user terminal) and 3B (railway control apparatus) below.

FIGURE 3A



Id., Fig. 3A, 6:18-41, 9:2-5 (“The terminal 103 could be any communication device such as, but not limited to, mobile phone or smartphone, tablet, WIC (or another) pager, PDA, etc.”) (emphasis added).

FIGURE 3B



Id., Fig. 3B, 6:4-11 (“The user interface 101D may be a mobile application, a web page or some other software component, on a terminal device.”), 6:42-7:20.

B. Claims

49. The table below includes identifiers for the '782 Patent claims and limitations, which are referenced throughout.

Claim Designation	Claim Language
Claim 1	
1[Pre]	A system to enhance railway control, to protect safety of railway workers on or near railway tracks, the system comprising:
1[A]	a railway control apparatus comprising a processor, a non-transitory medium storing one or more programs of executable instructions, and a network interface through which the railway control apparatus communicates via a network; and
1[B]	a user terminal provided to a railway field worker and configured to communicate via the network with the railway control apparatus and to provide a user interface to display information received from the railway control apparatus and to permit the railway field worker to respond to prompts displayed thereon,
1[C]	wherein the railway control apparatus, by execution of said one or more programs of executable instructions by the processor, includes: a block placing part to place a block on one or more specified track sections to permit the railway field worker to enter the track sections while blocking railway traffic to said track sections;
1[D]	a code generation part to generate a release code and transmit the release code to an electronic contact address accessible by the railway field worker via operation of the user interface of the user terminal; and
1[E]	a block removal part to remove only upon receiving the release code from the user terminal in return, the block placed by the block placing part on said one or more track sections.
Claim 2	
[2]	The system of claim 1, wherein upon the railway control apparatus placing the block of railway traffic to said one or more specified track sections and transmitting the release code to the electronic contact

	address accessible by the railway field worker, the user interface provided on the user terminal displays a message and permits the railway field worker to respond to the message to release the block.
Claim 3	
[3]	The system of claim 2, wherein upon the railway field worker responding to the message to release the block, the release code is returned to the railway control apparatus.
Claim 4	
[4]	The system of claim 2, wherein the message displayed by the user interface on the user terminal includes an embedded link for activating a return transmission of the release code to the railway control apparatus.
Claim 5	
5[Pre]	A method to enhance railway control, to protect safety of railway workers on or near railway tracks, said method comprising:
5[A]	configuring a mobile user device of a railway field worker to provide a device user interface to display information received via a network from a railway control apparatus and to permit the railway field worker to respond to prompts displayed thereon;
5[B]	providing a terminal user interface on a terminal to permit a terminal user of the terminal request the railway control apparatus to place a block on one or more specified track sections to permit a railway field worker to enter the track sections while blocking railway traffic to said track sections;
5[C]	generating by the railway control apparatus a release code and transmitting the release code to an electronic contact address accessible by the railway field worker via operation of the user interface of the user terminal; and
5[D]	permitting the block to said one or more track sections to be removed by the railway control apparatus only upon receiving the release code from the user terminal in return.
Claim 6	

[6]	The method of claim 4 5 ¹ , further comprising: displaying, upon the railway control apparatus placing the block of railway traffic to said one or more specified track sections and transmitting the release code to the electronic contact address accessible by the railway field worker, a message through the device user interface provided on the mobile user device and permitting the railway field worker to respond to the message to release the block.
Claim 7	
[7]	The method of claim 6, further comprising: upon the railway field worker responding to the message to release the block, returning the release code to the railway control apparatus.
Claim 8	
[8]	The method of claim 2 7 ² , wherein the message displayed by the device user interface on the mobile user device includes an embedded link for activating a return transmission of the release code to the railway control apparatus.

C. Prosecution History

50. During prosecution, the '782 Patent never received a substantive office action, but instead the Examiner issued a Notice of Allowance allowing the as-filed claims 1-8. EX1002.

¹ This change is based on the January 13, 2018 Certificate of Correction. EX1001, last page.

² This change is based on the January 13, 2018 Certificate of Correction. EX1001, last page.

51. A Certificate of Correction was issued on January 13, 2018 to change claim 6's reference of claim 1 to claim 5 and claim's 8 reference of claim 2 to claim 7. EX1001, last page.

D. Priority Date

52. I have been asked to assume for the purpose of this declaration a priority date of October 21, 2013 (the "Priority Date") but to reserve the right to offer opinions about this priority date (and priority chain) before the PTAB and district court if asked.

IX. INTERPRETATION OF THE '782 PATENT CLAIMS

53. I understand that, for purposes of my analysis, the claim limitations should be given their plain and ordinary meaning.

X. SUMMARY OF RELEVANT PRIOR ART

A. Overview of Oriol

54. Oriol (EX1004) was not considered during prosecution of the '782 Patent. Oriol was published by the U.S. Department of Transportation, Federal Railroad Administration in October 2004.

55. Oriol was available to the relevant public in at least two ways: "This document is available to the public through the National Technical Information Service, Springfield, VA 22161. This document is also available on the FRA website at www.fra.dot.gov." EX1004, front page, Report Documentation Page ("12a.

Distribution/Availability Statement”), notice page (“This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange.”)

56. Oriol was accessible to a POSITA based on the FRA’s statements above that Oriol was “available to the public” (or could be accessed) in multiple ways.

57. I also note that the Wayback Machine shows Oriol was available at www.fra.dot.gov in, for instance, 2005, 2006, 2008, and 2009. EX1013-1016 (*see* “DOT/FRA/ORD-04/13.i”); EX1022 (Internet Archive affidavit for the websites in EX1013-1016).

58. I further could access Oriol in EX1013-1016.

59. Lastly, another reference, Masquelier (EX1005), cites Oriol which further demonstrates that Oriol was available to the public. EX1005, ix, 3, 5, 72.

60. Oriol teaches that a railway worker operates a mobile device (PDA) to request work authorization over the Internet to a central control system (*e.g.*, web server, query server, and database) operated by a dispatcher.

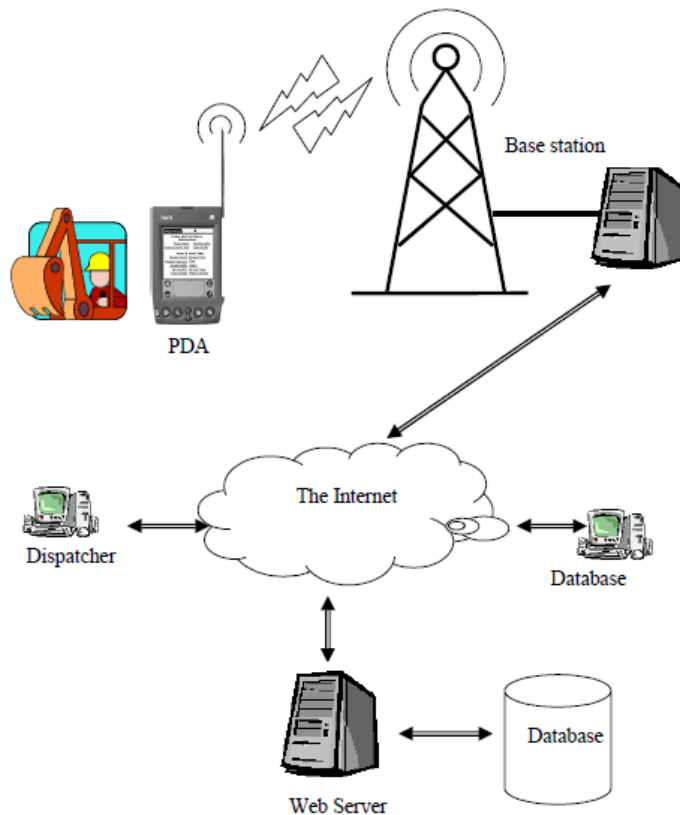


Figure 2. PDA System Architecture

EX1004, Fig. 2, 29 (“The PDA also enabled the roadway worker to request a variety of work authorizations (Form D . . .).”)

61. The work authorization can include, *e.g.*, a track car for “inspection or maintenance” denoted as Form D “Lines 2, 3” and worker’s “work involves on-track equipment or will disturb the track” known as Form D “Line 4.” *Id.*, 7, 8.

Figure 4 below shows a mobile interface to request the Form D work authorization:

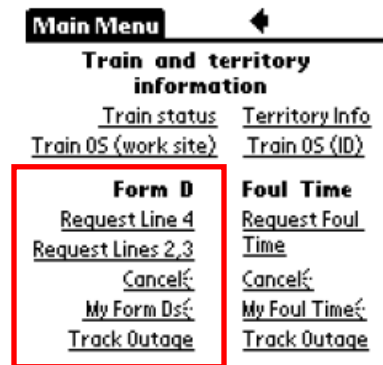


Figure 4. Main Menu (second version)

Id., Fig. 4 (annotated).

62. After receiving the work authorization request, and if the work is permitted, the dispatcher's central control system will block the track and transmit the railway worker a "Form D number (automatically assigned by system)." *Id.*, 38 (Form D line 4: "If the **dispatcher grants the Form D, the appropriate information will be sent to the roadway worker . . . includ[ing] Form D number (automatically assigned by system),** Form D recipient . . . [and other information]") (emphasis added), 6.

63. After completing the work, the railway worker selects "Cancel/Fulfill" link or prompt from the PDA's interface to transmit the Form D number to the dispatcher's central control system to unblock the track. *Id.*, 36, 37 ("Retrieve list of active Form Ds: Used whenever a roadway worker has finished their job or wants to cancel or fulfill a Form D and is giving the track back to the dispatcher. . .

Cancel/fulfill Form D: Works together with the previous request. This is the step to actually cancel or fulfill the Form D.”) (emphasis in original), Fig. A-1 (“You own these form Ds 0003, NorthEast Corridor . . . Cancel/Fulfill . . . NorthEast Corridor dispatcher has received your request and the form D # 0003 has been cancelled.”)

B. Overview of Masquelier

64. Masquelier (EX1005) was not considered during prosecution of the ’782 Patent. Masquelier was also published by the U.S. Department of Transportation, Federal Railroad Administration in October 2004.

65. Masquelier is the second volume of Oriol’s publication and builds upon Oriol’s work. EX1005, title, ix (“The current analysis of user requirements supported Oriol et al. (2004) findings.”), 3 (“This report describes the continuing development and evaluation of the application to enable roadway workers to communicate using digital communications.”), 5 (“information described here adds to roadway worker requirements reported by Oriol”), 72.

66. As with Oriol, Masquelier was available to the relevant public: “This document is available to the public through the National Technical Information Service, Springfield, VA 22161. This document is also available on the FRA website at www.fra.dot.gov.” *Id.*, front page, Report Documentation Page (“12a. Distribution/Availability Statement”), notice page (“This document is disseminated

under the sponsorship of the Department of Transportation in the interest of information exchange.”)

67. Masquelier was accessible to a POSITA based on the FRA’s statements above that Masquelier was “available to the public” (or could be accessed) in multiple ways.

68. I also note that the Wayback Machine shows Masquelier was available at www.fra.dot.gov in, for instance, 2005, 2006, 2008, and 2009. EX1013-1016 (*see* “DOT/FRA/ORD-04/13.ii”); EX1022 (Internet Archive affidavit for the websites in EX1013-1016).

69. I further could access Masquelier in EX1013-1016.

70. Masquelier teaches that a railway worker operates a mobile device to request work authorization, *e.g.*, Form D, over the Internet to the dispatcher’s centralized server. EX1005, Abstract, 16-18.

71. Masquelier teaches performing the same tasks as described in Oriol but additionally teaches, *e.g.*, the dispatcher and railway worker can communicate over text messages (SMS) relating to work authorization. *Id.*, 15 (“The PDA used the same Palm operating system as the first prototype, enabling the application to perform the same tasks as the first prototype.”), 21 (“The current hardware platform can use SMS to send and receive messages.”)

72. After receiving the work authorization request, and if the work is permitted, the dispatcher's central control system will block the track, which is shown in a visual interface (Figure 1 below). *Id.*, 11 (“At the Traffic Control Center, the dispatcher could use the track display to protect the track segment in question using software that controlled various switched and signals in the field.”).

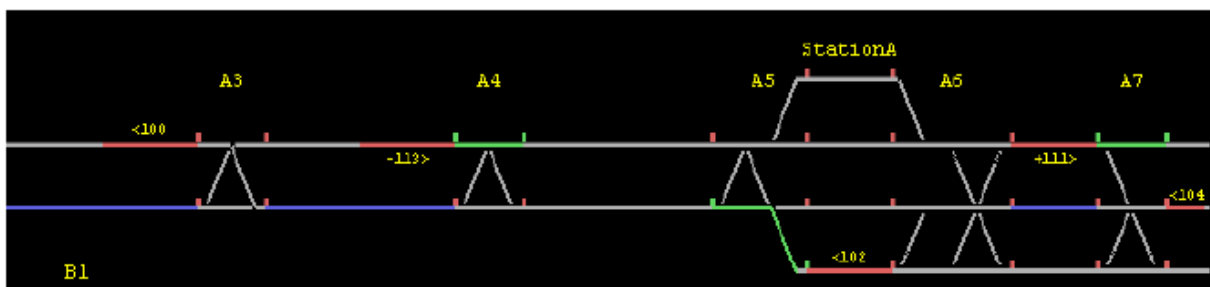


Figure 1. Track Chart Display

Id., Fig. 1 (color-coded display showing tracks blocked (blue) and unblocked).

Table 2. Representation of Color Code for Monitoring Track Status

Color	Meaning
White	Indicates that the track segment is available for routing trains or other uses.
Red	Means train or track vehicle occupancy. A train currently occupies that block.
Green	Indicates that the track segment has been cleared (authorized for use) for train movement. The train has not yet entered this block.
Blue	Indicates that a track section is authorized for track maintenance. This means that a portion of track has been protected for use by maintenance of way crews or track equipment. When the dispatcher gives track authority to a work crew, the dispatcher temporarily loses control over that section of track. Trains cannot enter this track segment unless authorized by the roadway worker responsible for that block.

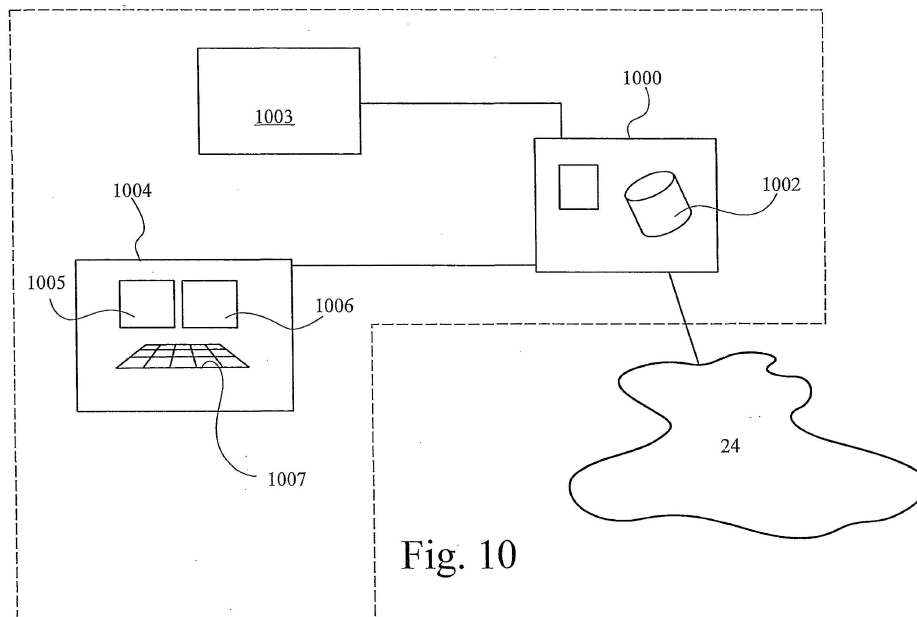
Id., Table 2 (outlining color meanings).

73. Once the work is complete, “the roadway worker returns control of the track to the dispatcher, who releases the track for other uses.” *Id.*, 12.

C. Overview of Wise

74. Wise (EX1006) was published on May 21, 2004 and is prior art under, at least, post-AIA 35 U.S.C. § 102(a). It was not considered during prosecution of the '782 Patent. I understand that Wise was cited during the prosecution of RE'835 Patent and RE'115 Patent.

75. As shown in Figure 10 below, Wise teaches a remote station / call center (central control) with a processor 1000 that communicates over a network 24 (Internet) with a worker's mobile terminal 20.



Id., Fig. 10, 27:22-28:4.

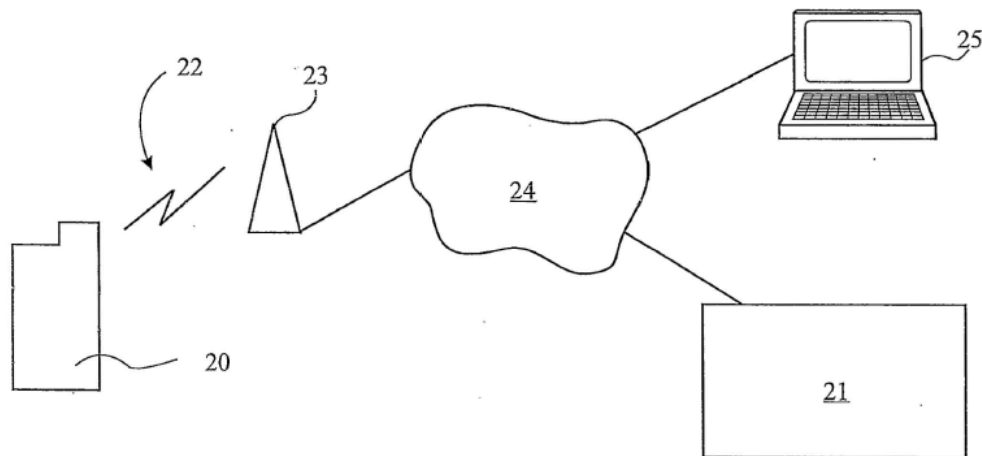


Fig. 2

Id., Fig. 2, 9:23-28 (“Figure 2 illustrates the remote access system. The assessor user uses a mobile terminal 20 to call a remote 25 station 21. The remote station and mobile terminal are connected via a wireless communication link 22 base transceiver station 23 and a router illustrated as the internet 24.”)

76. After the worker requests a safety measure (denoted as a green zone),³ the central control system blocks the track using signal lights and then generates an access code, *e.g.*, safety check number (“SCN”), which is provided to the worker.

Id., Fig. 5H (“Press the traffic-light icon on the toolbar & the SCN is automatically

³ The color-coding in Wise is assigned different meanings than in Oriol and Masquelier, but the principle of blocking a track using signals and switches remains the same.

generated”), claims 1 (“providing said user with an access code”), 16, 17, 12:6-15 (SCN “authorises/permits the user . . . to carry out work and access a work site.”), 24:19-26 (“This number may then be verbally given to the caller at step S553”), 7:33-8:2 (“[G]reen zone refers to a location where there is a blockage such a[s] traffic lights”), 30:20-24 (“operators . . . may take steps . . . by controlling traffic lights in the region, controlling the speed of trains or preventing trains from running.”), 29:32-30:3 (“operators will be responsible for controlling signalling”).

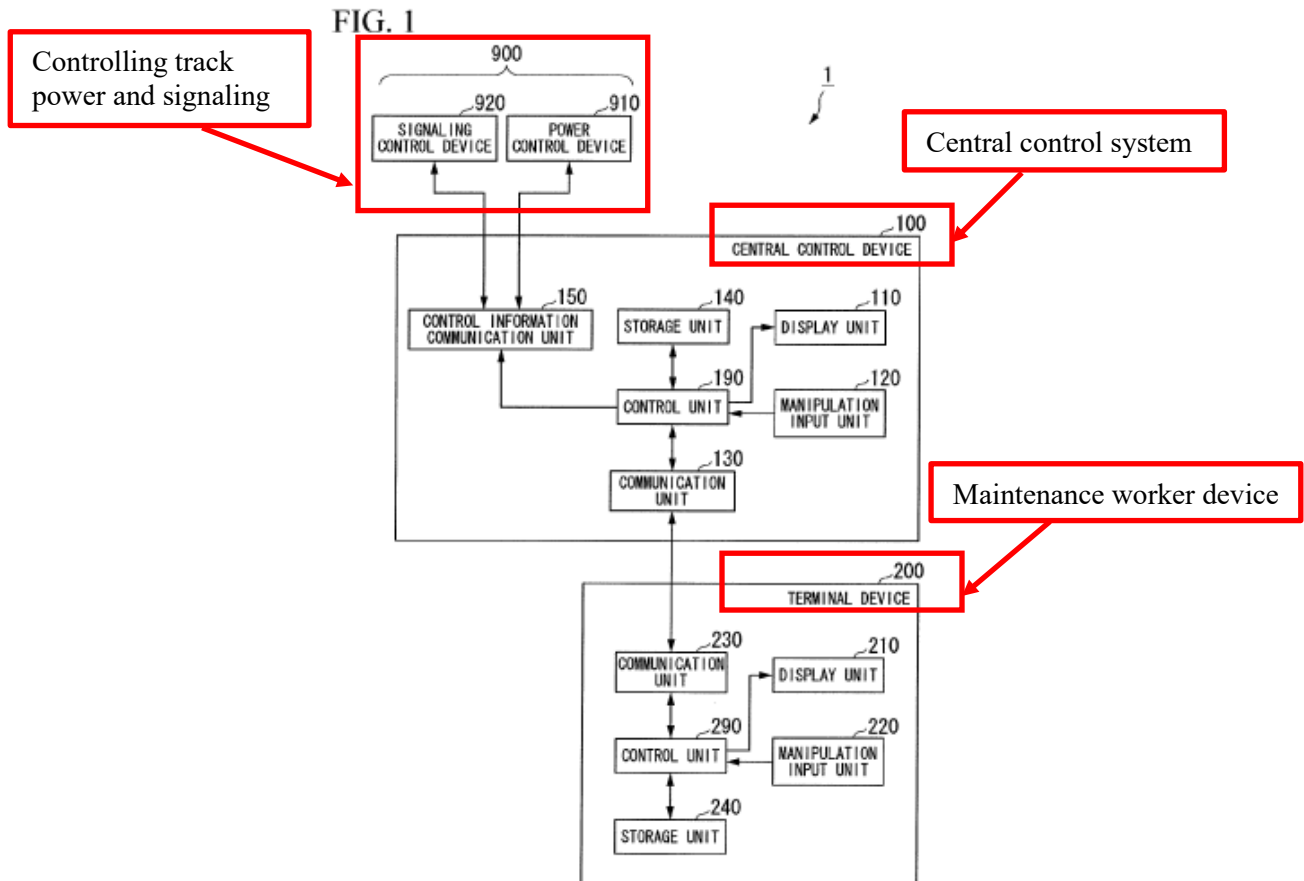
77. When the work is complete, the worker transmits the same code or “SCN number . . . previously . . . allocated to the job” to the central control system to release the work. *Id.*, 25:4-9.

D. Overview of Tamaribuchi

78. Tamaribuchi (EX1007) was published on July 12, 2012 and is prior art under, at least, post-AIA 35 U.S.C. § 102(a). Although Tamaribuchi was cited on the face of the ’782 Patent, it was not considered during prosecution of the ’782 Patent as discussed here. I understand that Tamaribuchi was also cited during the prosecution of RE’835 Patent and RE’115 Patent.

79. Tamaribuchi describes a central control system that communicates with a maintenance worker’s terminal device (*e.g.*, PDA) over a network (*e.g.*, Internet),

and the central control system communicates with a power and signaling system to block and unblock tracks.



Id., Fig. 1 (annotated).

80. The worker operates a user terminal to request “Track closure” from the central control system, which then blocks the track by stopping power and displaying a signal to prohibit train entry. *Id.*, Fig. 2, [0082], [0089], [0130].

81. The central control system generates and transmits a reference number, *e.g.*, serial number, to a worker's device. *Id.*, [0119], [0110] ("The reference number . . . is an identification number . . . for example, a serial number").

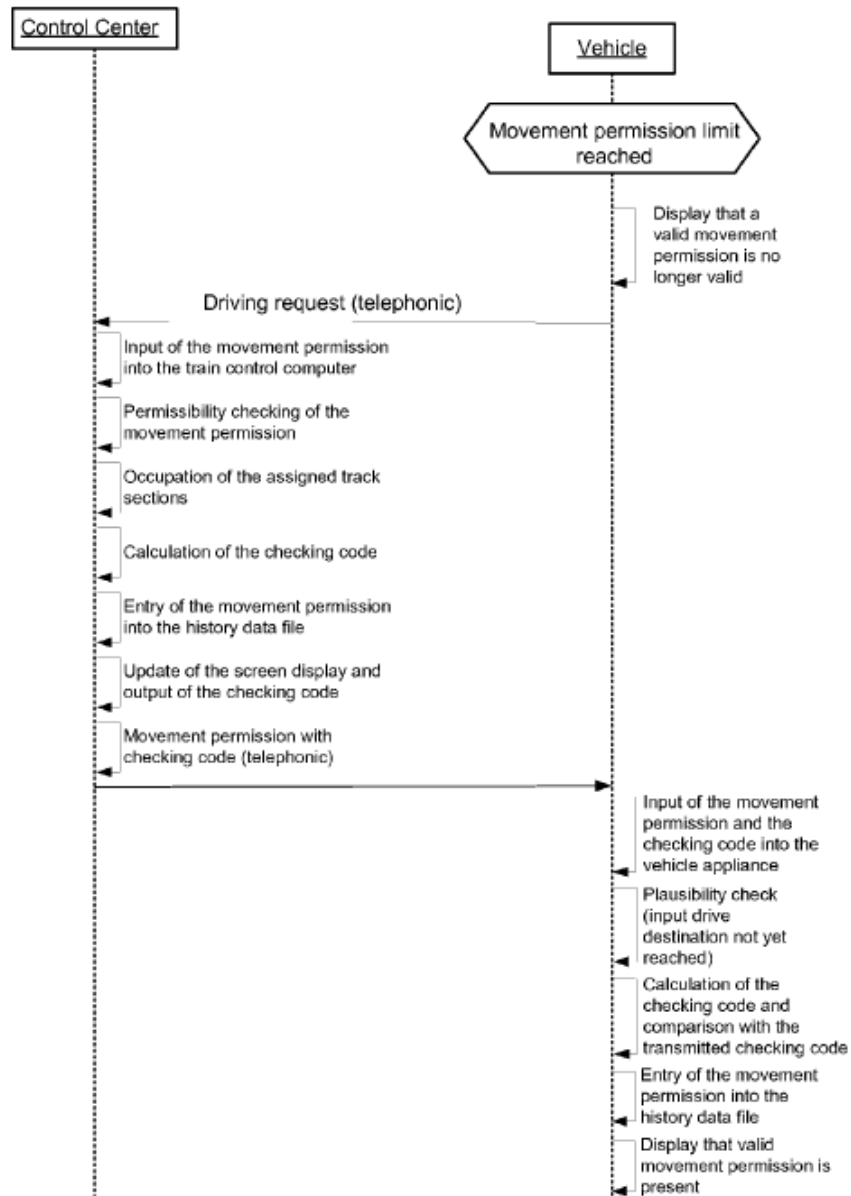
82. After the work is completed, the worker transmits the same release code to the railway control apparatus to unblock the track. *Id.*, [0167] ("communication unit 230 transmits the request for PIN lock release including the reference number . . . to the central control device 100."), [0200], [0202].

E. Overview of Pachl

83. Pachl (EX1020) teaches a control center with a computer interface and storage to first control the track safety measure and then generate a "checking code." *Id.*, 1:33-36 ("The introduction of the checking code which is specific to the movement permission technically precludes the transmission of a movement permission for which the safety preconditions are not satisfied."), 3:35-40 ("train control computer to be integrated in the control interface for electronic control systems . . . to control . . . train control sections from one user interface."), 1:11-20, 1:54-58, 1:63-66, 4:9-19, Abstract.

84. Figure 1 is provided below.

FIG.1

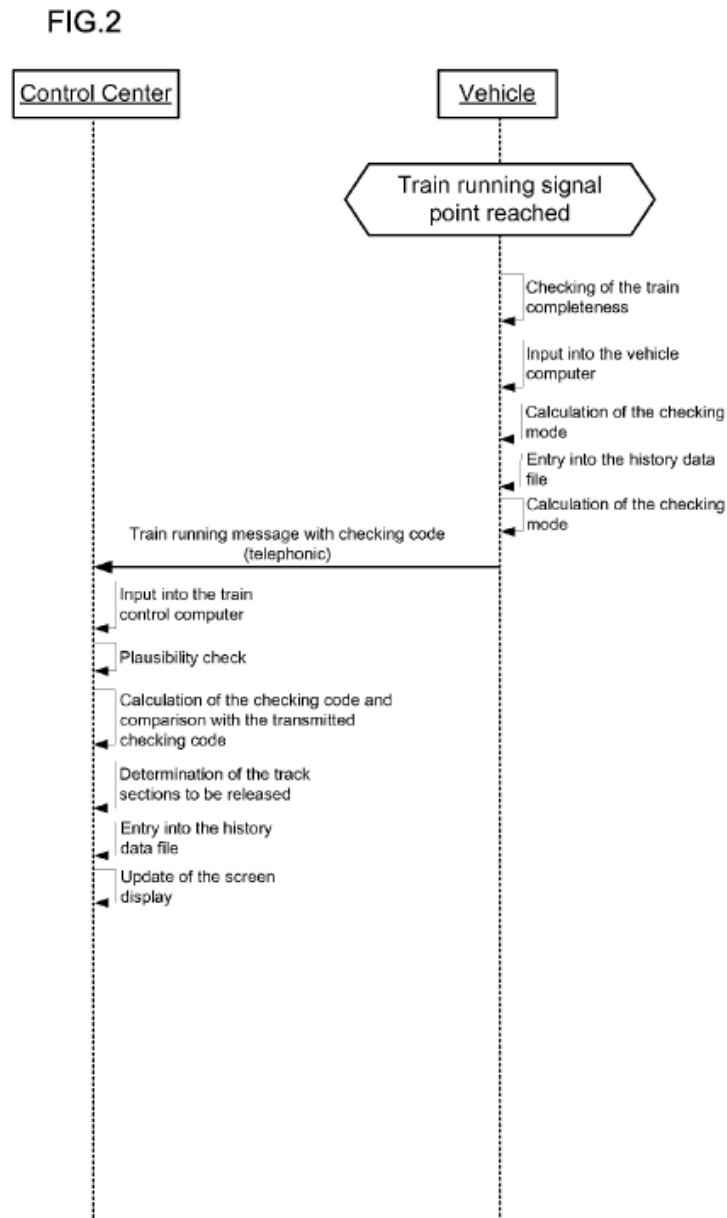


Id., Fig. 1.

85. Pahl further teaches that the control center will only release the track upon entry of a received code. *Id.*, 2:47-50 (“The locomotive engineer then transmits

the train running message together with the checking code to the train controller, who enters both data records in the train control computer.”), 2:55-60 (“Since the train controller cannot determine the checking code himself and is thus instructed to enter a valid train running message in response to the transmission of the checking code by the locomotive engineer, it is impossible for an associated track section to be released erroneously.”)), 4:50-59 (“The train running message and checking code are entered in the train control computer The track sections to be released are then defined and are entered in the history file. The screen display confirms the correctness of the train running message or, if appropriate, signals a fault state.”), 1:63-66, 4:15-18, claims 1, 5.

86. Figure 2 is provided below.



Id., Fig. 2.

XI. ANALOGOUS ART

87. Each prior art reference is analogous art to the claimed invention in the '782 Patent.

88. And each is in the same field of endeavor of railway control as in the '782 Patent. *Compare* EX1001, title, Abstract, 1:15-18, 2:43-46, 4:1-3, with EX1004, Abstract, 6, 13-14, 31-39, Figs. A-1-A-4, 2; EX1005, Abstract, 10-12, 15-18, 21, Figs. 1-2, 4, Table 2; EX1006, Abstract, Fig. 5H, claims 1, 16, 17, 7:33-8:2, 12:6-15, 24:19-26, 25:4-9, 27:22-28:4, Figs. 2, 10; EX1007, Abstract, Figs. 1-2, [0082], [0089], [0167]; EX1020, 1:54-66, 3:35-45, 4:9-15, Abstract, Figs. 1-2, title, claim 1; EX1019, Abstract, 4:35-53, claims 14-15; EX1021, Abstract, Fig. 4, 4:10-17, 4:48-65, 5:24-30, 5:59-6:9, claim 1; EX1018, Abstract, 1:13-2:2, 5:1-11; EX1017, Abstract, 3:9-15, Figs. 10-11.

89. Additionally, each is reasonably pertinent to any purported problem addressed in the '782 Patent. *Id.*; EX1001, title, Abstract, 1:15-18, 2:43-46, 4:1-3.

XII. GROUND 1: ORIOL MAKES CLAIMS 1-8 OBVIOUS

A. Analysis of Independent Claims 1, 5

1[Pre]: “A system to enhance railway control, to protect safety of railway workers on or near railway tracks, the system comprising:”

5[Pre]: “A method to enhance railway control, to protect safety of railway workers on or near railway tracks, said method comprising:”

90. Whether or not the preamble is limiting, Oriol teaches 1[Pre] and 5[Pre].

91. Oriol teaches enhanced railway control to protect the safety of railway workers on or near tracks with the worker operating a user terminal such as a PDA

to block and unblock tracks. EX1004, Abstract (“[a] prototype communications device was developed for roadway workers . . . to request track protection from the dispatcher.”), Preface (“digital communication device intended to improve roadway worker safety and productivity.”), 6 (“When a dispatcher receives a request for roadway worker protection . . . [and if granted under Form D] . . . the track is placed off-limits (blocked) for other uses. In Central Traffic Control (CTC) territory, blocking a track protects the roadway worker since it prevents the dispatcher from routing trains on that track. . . . Roadway workers’ tasks include . . . maintenance, and repair of the track . . . on or near the track.”), 37 (“worker has finished their job or wants to cancel or fulfill a Form D and is giving the track back to the dispatcher. . . .”), Figs. 2, A-1, A-3, 29 (“The PDA also enabled the roadway worker to request a variety of work authorizations (Form D . . .).”)

1[A]: “a railway control apparatus comprising a processor, a non-transitory medium storing one or more programs of executable instructions, and a network interface through which the railway control apparatus communicates via a network;”

92. Oriol teaches 1[A].

93. In Oriol, the railway control apparatus consists of at least the dispatcher’s computer, database, and web server (query server) with associated database, as shown below.

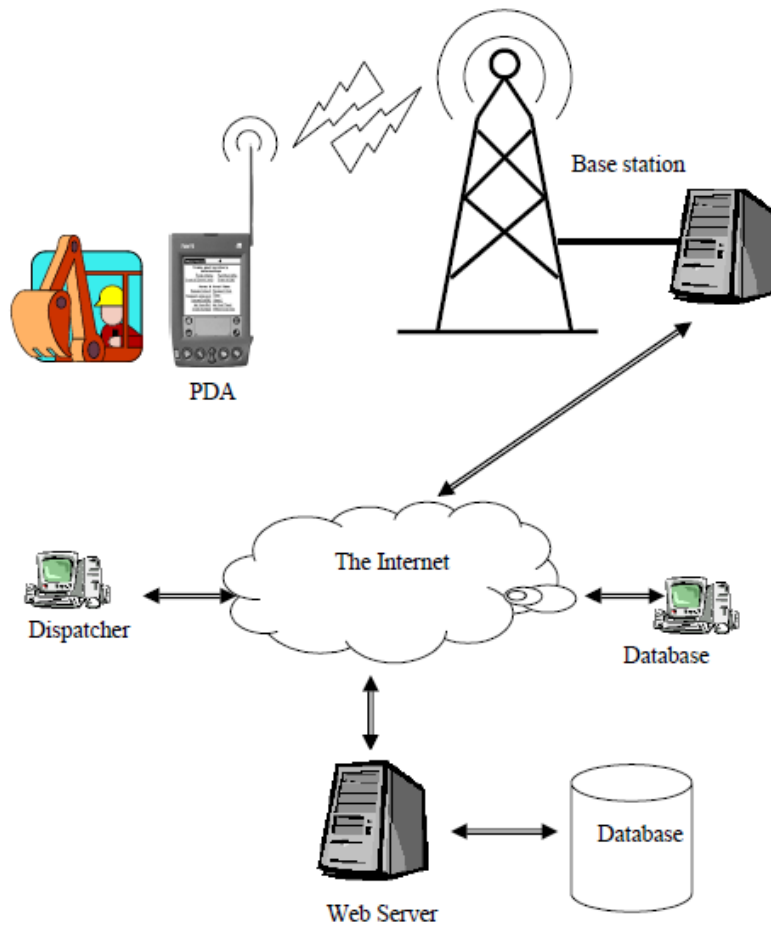


Figure 2. PDA System Architecture

EX1004, Fig. 2, 31 (describing components of Fig. 2, including query servers “[r]un on the same computer as the web server”), 6, 13-14 (“These servers represent the core of the system”).

94. This railway control apparatus has a network interface through which it communicates via a network, such as the Internet, with the worker’s PDA. *Id.*, 31, 38 (“If the dispatcher grants the Form D, the appropriate information will be sent to the roadway worker”), 37 (“**Dispatcher Query Server.** Handles requests sent by the

PDA that need dispatcher interaction such as requests that have to do with work permissions and answers sent by dispatcher to the PDA”) (emphasis in original), 36, A-1, A-3, A-5, x (“The prototype device operated on a personal digital assistant (PDA) with wireless access to the Internet.”), Figs. 1-2 (“Internet”), 13 (“A device was selected that had wireless access to the Internet, and could be used anywhere along the track. A web site was used as the network interface for the prototype.”), Abstract (“A prototype communications device was developed for roadway workers to request train and territory information and to request track protection from the dispatcher. The device uses a wireless data link to send and receive information in digital form.”), iii; *see infra* claim 1[B]/5[A], 1[D]/5[C].

95. The dispatcher’s computer and web server (query server) with associated database would each have a processor and a non-transitory medium such as a hard drive or other storage for “storing one or more programs of executable instructions.”

96. It is known to a POSITA that computers (servers) will have hard drive(s), memory (such as RAM), and other storage to store data necessary for the computer. It is common for computers to have processors to execute software (or instructions) residing on the computers as they are invoked, such as an operating system and other applications.

97. For instance, Oriol describes its components as computers, which would each have a processor, and they along with the PDA use software. EX1004, Fig. 2 (showing computers), 31 (“dispatcher’s terminal” and query/web server described as a “computer”), 36 (“query servers used in this study were mainly written in Java (Sun Microsystems, 2001) [A] Common Gateway Interface (CGI) script . . . [was] used as an interface between the web server and the query servers. It reads the HTML forms as sent by the PDA . . . and returns the requested information to the PDA.”), 38-40 (“Web Servers . . . Query Servers . . . Dispatcher Terminal . . .”), 11 (“[A] software application was developed for use on a PDA”), Figs. A-1-A-5, Fig. 1 (“Dispatcher’s terminal”).

98. Additionally, it was known to a POSITA to use a central control computer to control railway tracks over a network. EX1001, 1:25-2:3.

1[B]: “a user terminal provided to a railway field worker and configured to communicate via the network with the railway control apparatus and to provide a user interface to display information received from the railway control apparatus and to permit the railway field worker to respond to prompts displayed thereon,”

5[A]: “configuring a mobile user device of a railway field worker to provide a device user interface to display information received via a network from a railway control apparatus and to permit the railway field worker to respond to prompts displayed thereon;”

99. Oriol teaches 1[B] and 5[A].

100. In Oriol, the user terminal includes a worker's PDA and other components as shown below.

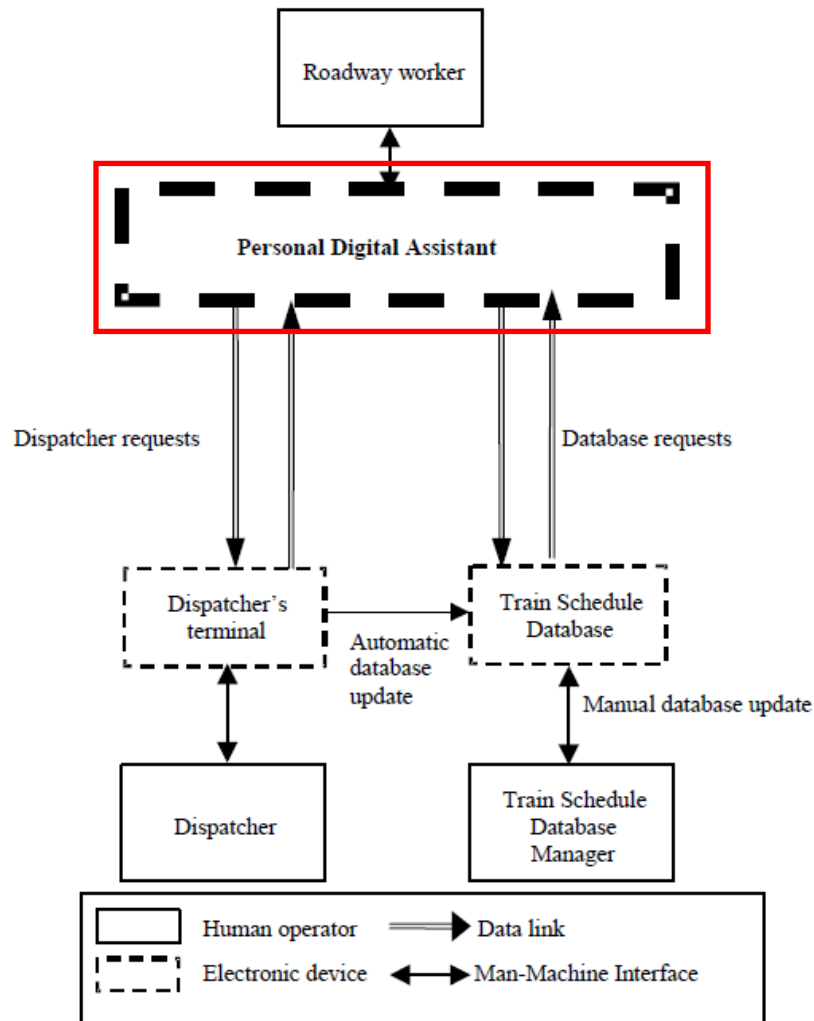


Figure 1. Information Flow Using PDA

EX1004, Fig. 1 (annotated).

101. Oriol describes that a worker's PDA communicates with the railway control apparatus over a network (*e.g.*, Internet), such as to request work

authorization. *See* claim 1[A]; EX1004, 29 (“The PDA also enabled the roadway worker to request a variety of work authorizations (Form D and Foul Time).”), 11 (“[A] software application was developed for use on a PDA with wireless communication capabilities. . . . The application was specifically designed for use on the railroad, and was intended to facilitate communication between roadway workers and dispatchers.”)

102. The worker’s PDA menu interface provides several functions, as shown in Figure 4 below, such as “Form D” work authorization including “Request Line 4” and “Request Lines 2, 3.”

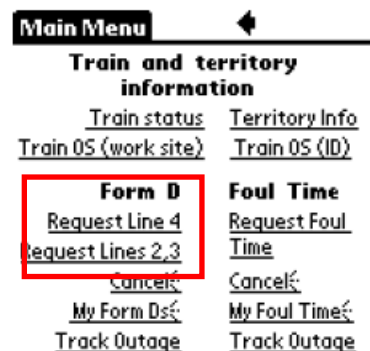


Figure 4. Main Menu (second version)

EX1004, Fig. 4 (annotated), 37 (“**Requests sent by PDA:** Request Form D line 4: . . . to perform a work that will require a Form D line 4 authorization.”) (emphasis in original).

103. A PDA is a user terminal or mobile device because a PDA as discussed above is a portable device that communicates over the Internet (or mobile network) and the '782 Patent describes the user terminal as a PDA. EX1001, 4:47-51, 9:2-5. The PDA could further “manag[e] e-mail,” demonstrating it is a mobile device. *Id.*, 13, 57.

104. Mr. Pirtle acknowledges mobile devices were well-known. EX1023, 2, 8 (¶¶ 5, 7), 15-16.

105. Oriol further discloses that the railway worker’s PDA interface displays links (from the railway control apparatus), which the worker can select and then respond to such prompts, *e.g.*, to request or cancel/fulfill work authorization. EX1004, 36 (“From the work request submenus, the roadway worker can request Form Ds (line 4 or lines 2 and 3) Following the link[] ‘Cancel/Fulfill’ . . . the roadway worker is able to give some track under his authority back to the dispatcher.”), 31 (“Web server. This server hosts the master files that are used as templates to send information back to the PDA.”) (emphasis removed), 36 (“The query servers . . . read[] the HTML forms as sent by the PDA . . . and returns the requested information to the PDA.”), 6.

106. Such displayed links are prompts because the worker is requested to select one of them to respond, such as a work authorization request.

107. The foregoing worker's PDA interface displaying and responding to prompts from the railway control apparatus is shown in Figure A-3 below.

Declaration of William R. Michalson
U.S. Patent No. 9,517,782

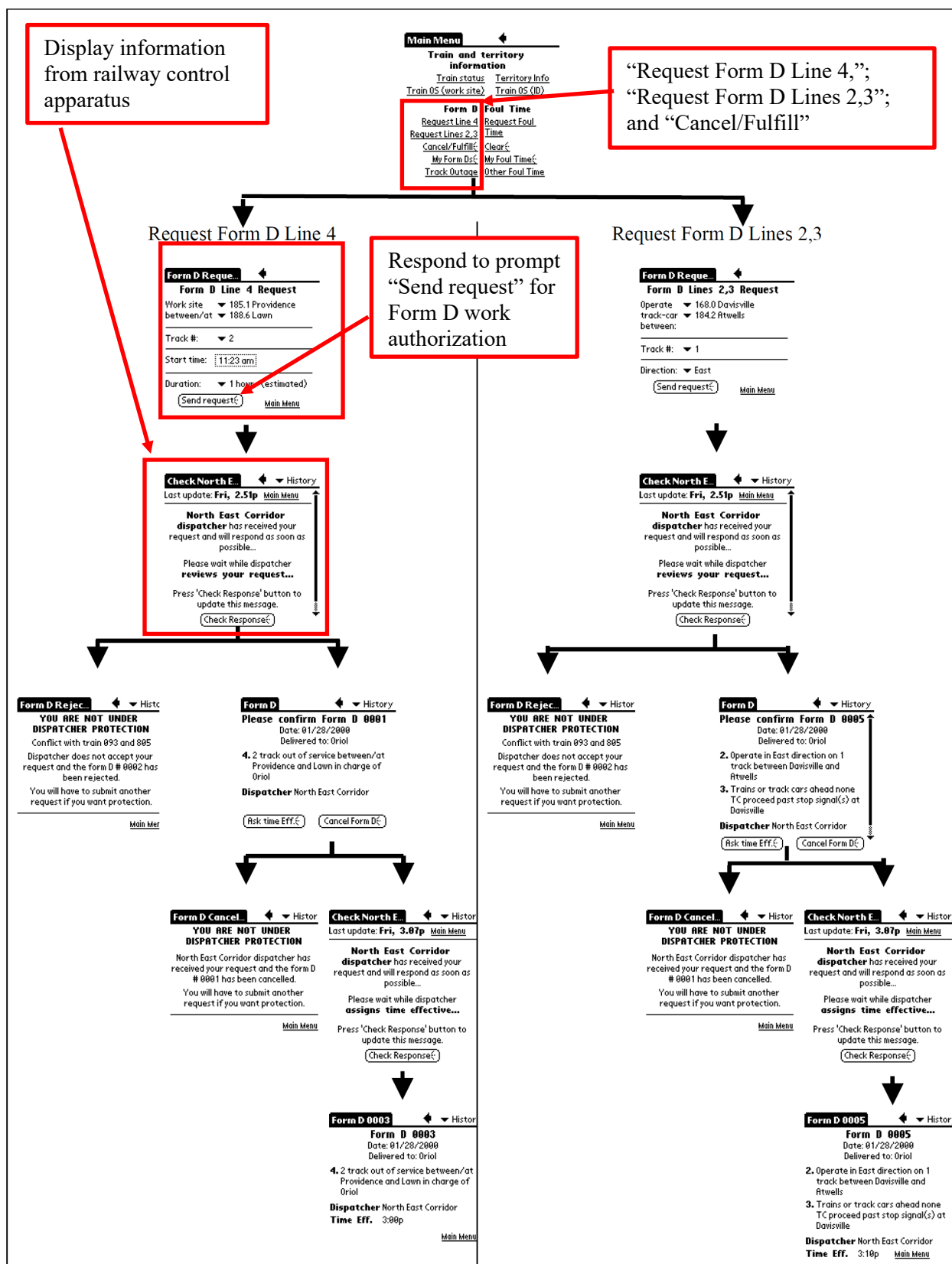


Figure A-3. PDA Screen Shots (3)

Id., Fig. A-3 (annotated), Fig. A-1 (“Cancel/Fulfill” prompt).

1[C]: “wherein the railway control apparatus, by execution of said one or more programs of executable instructions by the processor, includes: a block placing part to place a block on one or more specified track sections to permit the railway field worker to enter the track sections while blocking railway traffic to said track sections;”

5[B]: “providing a terminal user interface on a terminal to permit a terminal user of the terminal request the railway control apparatus to place a block on one or more specified track sections to permit a railway field worker to enter the track sections while blocking railway traffic to said track sections;”

108. Oriol teaches 1[C] and 5[B].

109. Claim 1 recites the “railway control apparatus, by execution of said one or more programs of executable instructions by the processor, includes: a block placing part [1[C]]. . . a code generation part [1[D]] . . . and a block removal part [1[E]]”

110. Claim 5 does not recite such parts, but merely requires the railway control apparatus to “place a block on one or more specified track sections.” I understand that using one or more software programs in the railway control apparatus would satisfy this claim element.

111. Because claim 1 recites “one or more programs,” I understand that to refer to one or more software programs executing on the railway control apparatus.

112. The specification describes software (“programming”) to implement the three parts. EX1001, 2:58-67 (“Such process may be largely automated via programming” including “the block placing part . . . a code generation part . . . [and] a block removal part”), 2:47-57 (“software”), 6:42-45 (“FIG. 3B shows an exemplary constitution of a computer 300 which can be configured by appropriate programming to operate as the railway traffic control apparatus 105 (FIG. 1A).”); EX1023, 2 (“claimed receipt, extraction and transmission of a secret code via voice message . . . one would cho[o]se from an available library of software.”)

113. These three parts could be implemented in “one” software program or “more [software] programs” based on claim 1.

114. Oriol implements the three parts in software via the railway control apparatus’ processor. *See* claim 1[A] (describing railway control apparatus’ software and hardware); EX1004, Fig. 2, 31, 36, 38, 39, Fig. A-5.

115. Additionally, implementing a program with executable instructions in a computer is known to a POSITA. EX1007, [0067], [0351], [0353].

116. Oriol teaches that the worker operates a PDA to request work authorization, *e.g.*, Form D Line 4, “on or near the track” from the railway control apparatus. *See* claims 1[Pre]/5[Pre], 1[B]/5[A]; EX1004, 6.

117. Based on this Form D request, the railway control apparatus' processor executes a block placing part (software) that blocks the track (also denoted as "out of service" for maintenance).

Query servers used in this study were mainly written in Java (Sun Microsystems, 2001) [A] Common Gateway Interface (CGI) script . . . [was] used . . [and] reads the HTML forms as sent by the PDA . . . and returns the requested information to the PDA.

. . . .

Dispatcher Query Server. Handles requests sent by the PDA that need dispatcher interaction

. . . .

Answer request for Form D line 4: Used by a dispatcher to grant or deny the requested Form D lines 4. If the dispatcher grants the Form D, the appropriate information will be sent to the roadway worker who requested it . . . [such as] Form D number (automatically assigned by system) . . . foreman in charge of the track out of service.

EX1004, 36-38 (emphasis added), 6 ("When a dispatcher receives a request for roadway worker protection . . . [and if] the dispatcher grants permission to work, (under . . . Form D . . .) the track is placed off-limits (blocked) for other uses. In

Central Traffic Control (CTC) territory, blocking a track protects the roadway worker since it prevents the dispatcher from routing trains on that track.”), 14 (“The database contained . . . track out of service under Form D”), 31, Abstract, 13.

118. This block placing part software is also shown in Figure A-3 below where the railway control apparatus blocks a track based on a work authorization request, particularly “**Form D Request Line 4 . . . Send Request . . . North East Corridor dispatcher has received your request . . . 2 track out of service between/at Providence and Lawn in charge of Oriol . . .**” *Id.*, A-3 (emphasis added). This exemplary blocking is also shown in Request Lines 2, 3 below.

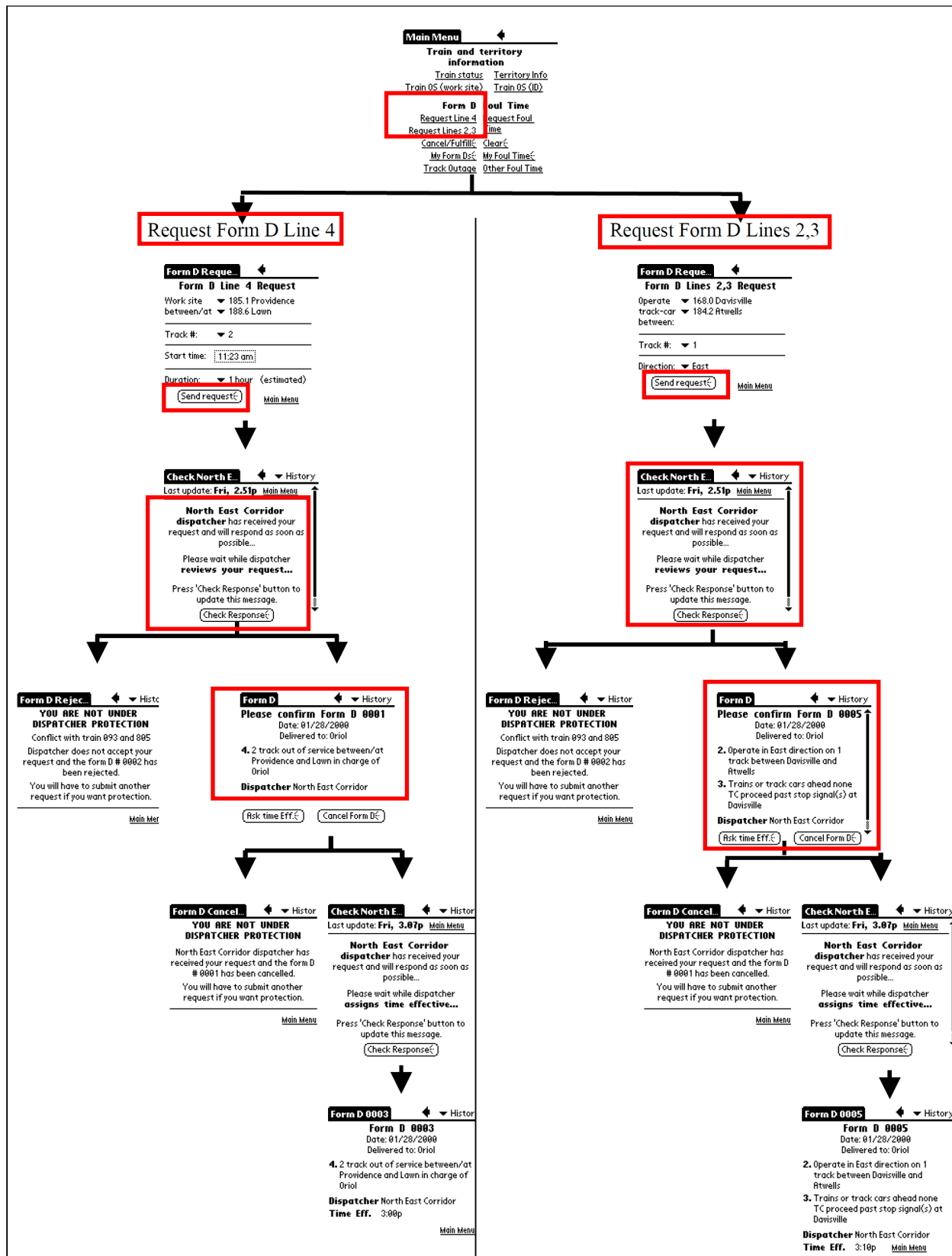


Figure A-3. PDA Screen Shots (3)

Id., Fig. A-3 (annotated), 31.

119. While the track is blocked, the railway worker can enter the track to perform, *e.g.*, maintenance work. *Id.*, Figs. A-1, A-3 (track “out of service” until cancelled/fulfilled), 6 (“the dispatcher grants permission to work, (under . . . Form D . . .) the track is placed off-limits (blocked) for other uses.”), 8 n.1 (Form D, Line 4 requires “the dispatcher to remove it from service while the authorization is in effect.”); *infra* claim 1[E]/5[D] (block in place until cancelled/fulfilled).

120. Additionally, it was known to a POSITA for central control to transmit a signal to the corresponding interlock to block a track. EX1001, 1:25-2:3.

1[D]: “railway control apparatus . . . includes . . . a code generation part to generate a release code and transmit the release code to an electronic contact address accessible by the railway field worker via operation of the user interface of the user terminal; and”

5[C]: “generating by the railway control apparatus a release code and transmitting the release code to an electronic contact address accessible by the railway field worker via operation of the user interface of the user terminal; and”

121. Oriol teaches 1[D] and 5[C].

122. Claim limitations 1[D]/5[C] require generating and transmitting a “release code,” yet they do not describe the “release code,” its contents, or how it is created.

123. Oriol teaches that the worker on the PDA selects the Form D work authorization link, such as “Request Form D Line 4” or “Request Form D Lines 2, 3,” and transmits such work authorization to the railway control apparatus. *See* claim 1[C]/5[B]; EX1004, Fig. A-3, 6, 14, 36-38. When the railway control apparatus grants the work authorization, it blocks the track. *Id.*

124. The railway control apparatus includes a code generation part (software) that generates a form D number (release code) and transmits that release code to the worker’s PDA or electronic contact address:

If the dispatcher grants the Form D [blocks the track], the appropriate information will be sent to the roadway worker who requested it. This information includes Form D number (automatically assigned by system), Form D recipient, date, track number, track location, and foreman in charge of the track out of service.

EX1004, 38 (emphasis added), 38 (Form D lines 2 and 3: “Form D number (automatically assigned by system)”), Fig. 1 (showing railway control apparatus transmitting data to PDA).

125. Oriol’s Form D number is a release code because the generated Form D number is sent to the worker “who requested it” (EX1004, 38) and who cancels

the same Form D number (or under his authority) to release the track block. *See infra* claim 1[E]/5[D] (unblock track by cancelling/fulfilling Form D number); EX1004, 36 (“worker can retrieve a list of Form Ds . . . under his/her authority . . . [and] [f]ollowing the link[] ‘Cancel/Fulfill’ . . . the roadway worker is able to give some track under his authority back to the dispatcher.”), 37 (“Retrieve list of active Form Ds: Used whenever a roadway worker has finished their job or wants to cancel or fulfill a Form D and is giving the track back to the dispatcher. . . Cancel/fulfill Form D: Works together with the previous request. This is the step to actually cancel or fulfill the Form D.”) (emphasis in original), Fig. A-1 (selecting “Cancel/Fulfill” to transmit the Form D number to the railway control apparatus which unblocks the track).

126. The worker’s PDA has an electronic contact address given that the release code is “sent to the roadway worker who requested it” and the worker’s PDA device ID is registered in the railway control apparatus database. EX1004, 38, 39 (“The database includes . . . Roadway workers (MWForemen.txt). Includes information about registered PDAs and their owner.”) (emphasis in original), 57 (“Each Palm VII device had a built in device ID . . . [and this] device ID was used to identify which roadway worker was sending each request.”), Figs. A-3 (“**Form D 0001 . . . Delivered to: Oriol**”) (emphasis added), A-5.

127. Additionally, because the communication is over the Internet, it would have been known to a POSITA that there would be, *e.g.*, an IP address (as well as a MAC address), for the PDA and that some, or all, of that information would be stored in the Oriol database for such Internet communication.

128. The railway control apparatus generating the release code and transmitting the code (accessible in the PDA's user interface) to the electronic contact address is also shown in Figure A-3 below, particularly "**Form D Line 4 Request . . . North East Corridor dispatcher has received your request . . . Please confirm Form D 0001 . . . Delivered to: Oriol . . . 2 track out of service between/at Providence and Lawn in charge of Oriol . . .**" *Id.*, Fig. A-3 (emphasis added); *id.* ("**Form D Lines 2,3 Request . . . Please confirm Form D 0005 . . . Form D 0005**") (emphasis in original).

Declaration of William R. Michalson
U.S. Patent No. 9,517,782

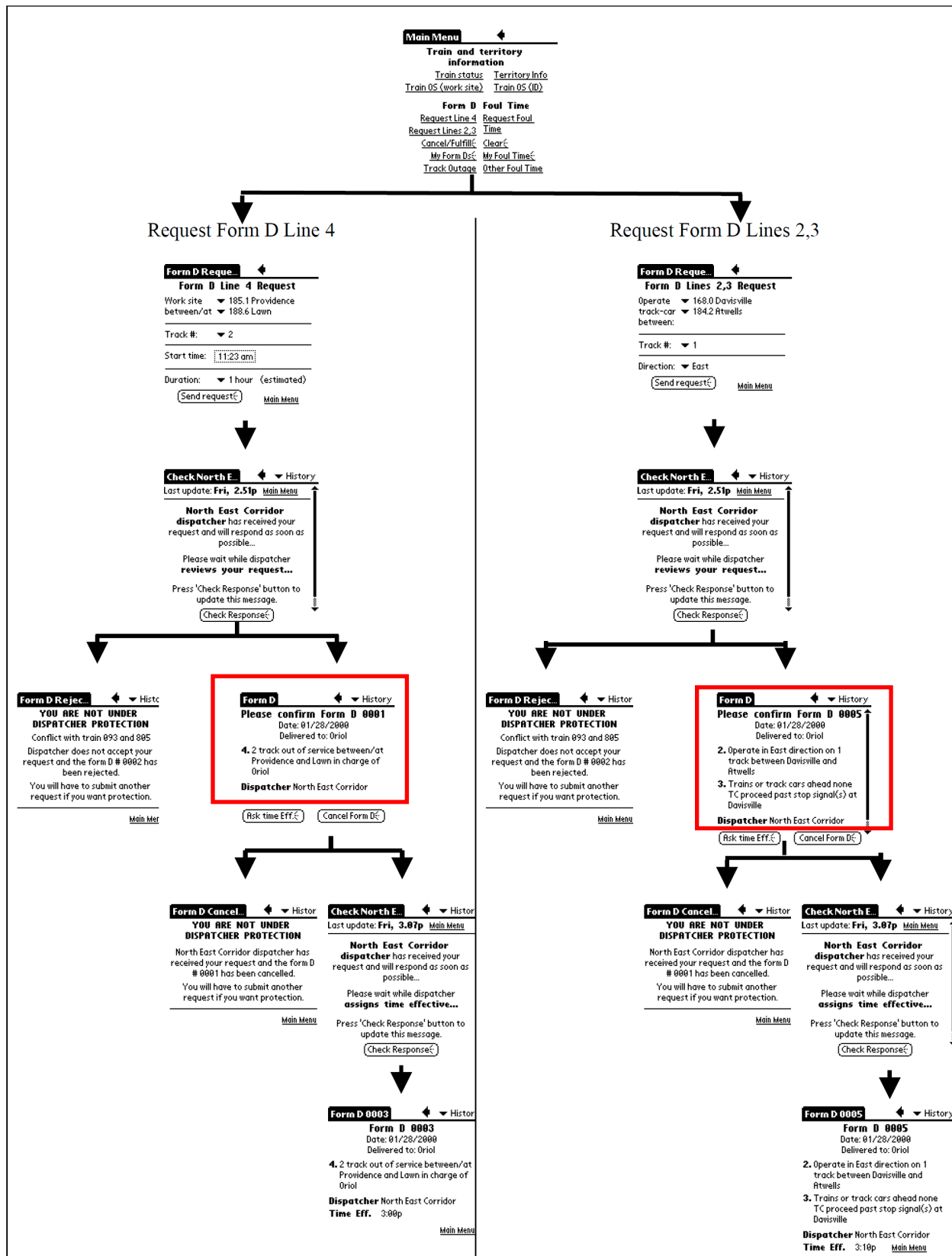


Figure A-3. PDA Screen Shots (3)

Id., Figs. A-3 (annotated),⁴ A-5 (dispatcher interface: “**Form D 0003 is Requested** . . . Form D #: 0003 Delivered to: Oriol . . . track out of service . . . Send Response [button].”) (emphasis in original), A-1 (“You own these form Ds 0003, NorthEast Corridor . . . NorthEast Corridor dispatcher has received your request and the form D # 0003 has been cancelled.”)

129. To the extent it is argued that claim limitations 1[D]/5[C] require that the code is generated after the track is blocked, Oriol teaches this as discussed above. *Id.*, 38 (“**If the dispatcher grants the Form D [blocks the track], the appropriate information will be sent to the roadway worker who requested it. This information includes Form D number (automatically assigned by system)**”)

⁴ There appears to be a typographical error for Form D 0001 in Fig. A-3, “Form D Line 4 Request” as it should state Form D 0003 since Form D 0003 is later used in the same diagram, the dispatcher’s interface shows Form D 0003 (EX1004, Fig. A-5), and worker cancels Form D 0003 (*id.*, Fig. A-1). Further, “Form D Lines 2,3 Request” shows the same Form D number (Form D 0005) twice, just as the Form D 0003 should appear. *Id.*, Fig. A-3. It is also consistent with Oriol teachings that the generated Form D number is sent to the worker “who requested it” (*id.*, 38) and cancels that same Form D number. *Id.*, 36-37, Fig. A-1; *see* claim 1[E]/5[D].

(emphasis added), Figs. A-3 (request track block, then block the track, and then send the generated Form D number with the tracked blocked), A-5.

130. In any event, a POSITA would have been motivated to modify Oriol to first block the track and thereafter generate the Form D number or code as this is merely one of two possible design choices.

131. Additionally, this modification could enhance safety and security as the central control system would only generate the code once the block has been implemented to ensure the release code could not be unsafely or incorrectly used before the track is blocked, such as to enter the track. It would also enhance efficiency because the Form D number would not always be generated but only after the track is blocked.

132. A POSITA would have a reasonable expectation of success because Oriol could generate a temporary number or other placeholder and then once the track is blocked, generate the Form D number to provide greater security and safety because the Form D number or release code would not be known until the track is blocked.

133. Oriol's railway control apparatus has existing hardware and software to block the track and then generate and transmit a Form D number. *See* claim 1[B]-[C].

134. And Oriol describes that “[t]he system is designed to be highly configurable,” which only improves the reasonable expectation of success. EX1004, 41.

1[E]: “railway control apparatus . . . includes . . . a block removal part to remove only upon receiving the release code from the user terminal in return, the block placed by the block placing part on said one or more track sections.”

5[D]: “permitting the block to said one or more track sections to be removed by the railway control apparatus only upon receiving the release code from the user terminal in return.”

135. Oriol teaches 1[E] and 5[D].

136. Oriol describes that “[o]nce authorization for track use is granted to a roadway crew and the track is blocked, the dispatcher has delegated authority over that track to the roadway crew.” EX1004, 6.

137. The “worker can retrieve a list of Form Ds . . . under his/her authority . . . [and] [f]ollowing the link[] ‘Cancel/Fulfill’ . . . the roadway worker is able to give some track under his authority back to the dispatcher.” EX1004, 36, 37 (“Retrieve list of active Form Ds: Used whenever a roadway worker has finished their job or wants to cancel or fulfill a Form D and is giving the track back to the dispatcher.”) (emphasis in original), 37 (“My Form Ds: Used to retrieve a list of current Form Ds . . . under the authority of the roadway worker holding the PDA.”) (emphasis in original), 36, 39 (“When a roadway worker wants to know about their own Form Ds

. . . they use the PDA to retrieve it from the web server. The roadway worker . . . will only tell the PDA they want to retrieve a specific Form D number”), 31, Fig. A-1; *see* claim 1[B]/5[A].

138. Accordingly, the track block is under the worker’s “authority” and the block is only removed when the worker selects the “Cancel/fulfill” link on their PDA (user terminal) to transmit the code to the railway control apparatus, thereby transferring authority back to the dispatcher.

139. Selecting this “Cancel/fulfill” link transmits the previously generated Form D number or release code (*see* claim 1[D]/5[C]) to the railway control apparatus block removal part (software), which only unblocks the track after receiving the same release code.

Dispatcher Query Server. Handles requests sent by the PDA that need dispatcher interaction such as requests that have to do with work permissions and answers sent by dispatcher to the PDA

. . . .

Retrieve list of active Form Ds: Used whenever a **roadway worker has finished their job or wants to cancel or fulfill a Form D and is giving the track back to the dispatcher.**

. . . .

Cancel/fulfill Form D: Works together with the previous request. This

is the step to **actually cancel or fulfill the Form D**.

EX1004, 37 (emphasis added), 6 (“When the job is completed . . . the dispatcher unblocks the track making it available for other uses.”), 11.

140. This block removal part (software) is also shown in Figure A-1 below where the railway control apparatus unblocks the track (or removes the track block) only based on receiving the same Form D number (release code) previously generated, particularly “**Cancel/Fulfill Form D . . . You own these form Ds 0003, NorthEast Corridor . . . Cancel/Fulfill . . . Form D Cancel . . . YOU ARE NOT UNDER DISPATCHER PROTECTION** NorthEast Corridor dispatcher has **received your request and the form D # 0003 has been cancelled.**” *Id.*, Fig. A-1 (emphasis added).

141. Thus, a specific form D “0003” is transmitted to the railway control apparatus to unblock the track as shown by the same Form D number, “form D# 0003,” being cancelled.

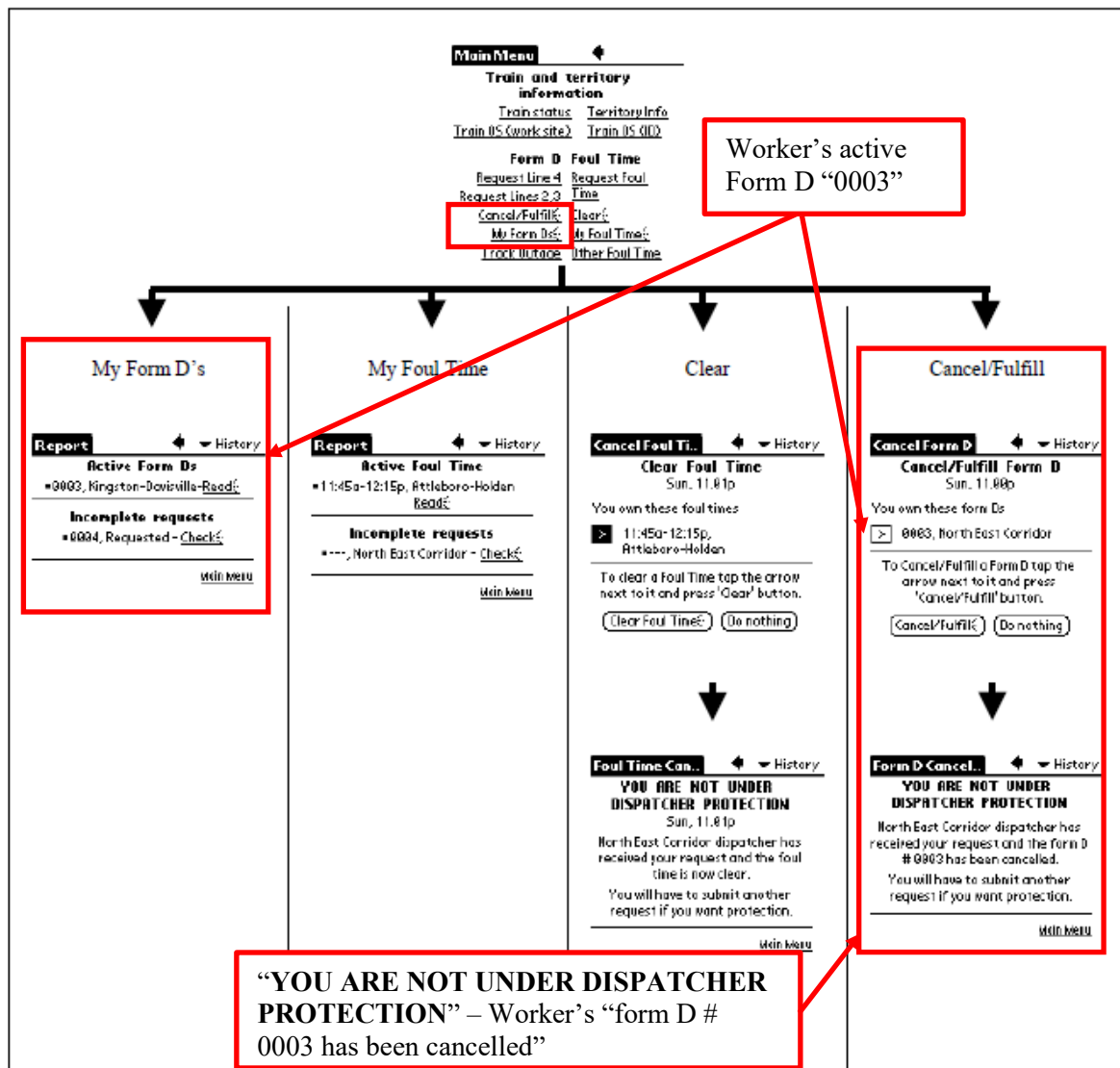


Figure A-1. PDA Screen Shots (1)

Id., Fig. A-1 (annotated).

142. It was known to a POSITA to provide railway authorization only upon receiving a matching code. EX1019, 4:35-42 (“The secure code transmitted from the designated train 101 must match the secure code that is expected by the dispatch office . . . before the movement authority can be transmitted.”), claims 14-15.

143. Claims 1 and 5 do not recite entry of the code rather they recite “receiving the release code.” To the extent it is argued otherwise, a POSITA would have been motivated to modify Oriol to have the dispatcher enter the release code or Form D number in the railway traffic control apparatus because it would provide another level of protection and confirmation before the track is unblocked. It will also ensure the dispatcher is alert to the information provided from the worker, such as unblocking the track.

144. Further, claims 1 and 5 recite “receiving the release code from the user terminal.” A POSITA would understand that receiving a code “from the user terminal” is a logical consequence of a dispatcher entering a release code on their user terminal.

145. A POSITA would have had a reasonable expectation of success because Oriol teaches a centralized dispatcher user interface and related software that a POSITA could have modified to include entry of the release code. *See* claim 1[A]; EX1004, 31, 36, 38, 39, Figs. A-1-A-5, 2; EX1005, 10-12, Figs, 1, 15, Table 2.

146. Also, Oriol notes that “[t]he system is designed to be highly configurable” which communicates to a POSITA that the system was designed to accommodate making this modification. EX1004, 41.

147. A POSITA would further have been motivated with a reasonable expectation of success to enter the release code because it was known to a POSITA to enter a received code for confirming a person was paying attention to allow train movement. EX1021, 4:10-17 (“[T]he unique code is designated for display to the operator H, for the operator H to enter the displayed code into the OCU 42 for purposes of confirming that the operator is paying attention to information”), 4:48-53 (“When the human operator H observes the image, he can ascertain whether or not the crossing is clear for the train 28 to enter. At the same time, he will read the unique code and then enter the code into the OCU 42. The OCU 42 then transmits the entered code to the LCU 40 as part of a response message/signal.”), 4:59-62 (“If the unique code is not received within the timeout period, an automatic pre-programmed response is taken by the LCU 40, such as a speed (e.g., throttle notch) reduction or a penalty brake application (block 112).”), Abstract (“if the unique code is not received by the locomotive control unit, carrying out an automatic response which prevents movement of the train through the crossing.”), 5:24-30, 5:59-65, claim 1, Fig. 4.

B. Analysis of Dependent Claims 2-4, 6-8

Claim 2: “The system of claim 1, wherein upon the railway control apparatus placing the block of railway traffic to said one or more specified track sections and transmitting the release code to the electronic contact address accessible by the railway field worker, the user interface

provided on the user terminal displays a message and permits the railway field worker to respond to the message to release the block.”

Claim 6: “The method of claim 1 5, further comprising:

displaying, upon the railway control apparatus placing the block of railway traffic to said one or more specified track sections and transmitting the release code to the electronic contact address accessible by the railway field worker, a message through the device user interface provided on the mobile user device and permitting the railway field worker to respond to the message to release the block.”

148. Oriol teaches claims 2 and 6.

149. Oriol teaches that the railway control apparatus receives the work authorization from the worker’s PDA and the railway control apparatus includes a block placing part (software) that blocks the track. *See* claim 1[C]/5[B]

150. Oriol further teaches that the railway control apparatus generates a release code and transmits that release code to the worker’s PDA or electronic contact address. *See* claim 1[D]/5[C].

151. The railway control apparatus displays this release code and other information on the PDA’s user interface. *Id.*

152. The worker’s PDA interface also displays a message, *e.g.*, embedded link of “Cancel/Fulfill” in Fig. A-1. *See* claim 1[E]/5[D]; EX1004, Figs. A-1, A-3.

153. This cancel/fulfill link would be considered a message because it can be responded to or activated by the worker to unblock the track. *See* claim 1[E]/5[D].

154. Alternatively, a POSITA would have been motivated to modify Oriol to transmit the Form D number or release code with, *e.g.*, embedded link of “Cancel/Fulfill” in Fig. A-1, in an email or text message to the worker to provide a more usable form.

155. Since the workers were familiar with email and cell phones they would be familiar with operating a user interface to enter and send text and numbers as a text message or an email. EX1004, 16 (“[a]ll participants were familiar with . . . cellular phones, the Internet, and e-mail.”), 13 (PDA can “manag[e] e-mail”).

156. The named inventor acknowledged in the application leading to the RE’115 Patent that mobile phones, text messaging and email were conventional before the Priority Date and thus indicates these known communication methods could be applied to railway systems. EX1023, 2, 8 (¶¶ 5, 7), 15-16.

157. Thus, a POSITA would have been motivated to apply these techniques to respond to a request.

158. Mr. Pirtle’s statements further show that a POSITA would have had a reasonable expectation of success because email and text message were conventional and Oriol describes that the PDA could “manag[e] e-mail.” EX1004, 13, 57 (PDA is “[a]ble to send and receive e-mail”).

159. As described by Oriol, a worker responds to the message (existing interface or modified as discussed above) by selecting the cancel/fulfill link to transmit the previously generated Form D number or release code to the railway control apparatus to release the track block. *See* claim 1[E]/5[D].

Claim 3: “The system of claim 2, wherein upon the railway field worker responding to the message to release the block, the release code is returned to the railway control apparatus.”

Claim 7: “The method of claim 6, further comprising:

upon the railway field worker responding to the message to release the block, returning the release code to the railway control apparatus.”

160. Oriol teaches claims 3 and 7. *See* claims 2/6, 1[E]/5[D]; EX1004, Fig. 1 (showing PDA sending data to dispatcher’s terminal).

Claim 4: “The system of claim 2, wherein the message displayed by the user interface on the user terminal includes an embedded link for activating a return transmission of the release code to the railway control apparatus.”

Claim 8: “The method of claim 2 7, wherein the message displayed by the device user interface on the mobile user device includes an embedded link for activating a return transmission of the release code to the railway control apparatus.”

161. Oriol teaches claims 4 and 8. Oriol teaches that the worker’s PDA displays a message with embedded links, such as “Cancel/Fulfill” in Fig. A-1, in the PDA user interface. *See* claims 1[E]/5[D], 2/6; EX1004, 36 (“Following the links

‘Cancel/Fulfill’ . . . the roadway worker is able to give some track under his authority back to the dispatcher.”), Figs. A-1, A-3.

162. Alternatively, a POSITA would have been motivated to include the embedded link in an email or text message for the reasons discussed above. *See* claims 2/6.

163. A POSITA would understand that when such a link is activated, it transmits the release code to the railway control apparatus to release the track block. *See* claims 2/6, 1[E]/5[D].

XIII. GROUND 2: ORIOL AND MASQUELIER MAKE CLAIMS 1-8 OBVIOUS

A. Motivation to Combine; Reasonable Expectation of Success

164. Masquelier is a second volume to Oriol’s publication and cites Oriol several times, such as Masquelier states the “continuing development and evaluation of the [Oriol] application” EX1005, 3 (“This report describes the continuing development and evaluation of the application to enable roadway workers to communicate using digital communications.”), title (similar title as Oriol), Abstract, ix (“The current analysis of user requirements supported Oriol et al. (2004) findings.”), 5 (“information described here adds to roadway worker requirements reported by Oriol”), 10-12, 16, 72, Fig. 4.

165. Thus, a POSITA would naturally have been motivated to combine them with a reasonable expectation of success.

166. A POSITA would also have been motivated to modify Oriol with Masquelier and had a reasonable expectation of success because both Oriol and Masquelier were published by the U.S. Department of Transportation FRA, share two overlapping authors, and discuss solutions using the same types of devices. EX1004, cover page, Report Documentation Page, title, Abstract, 29, 37, Fig. 2; EX1005, cover page, Report Documentation Page, title, ix, 3, 5, 72.

167. Additionally, there would have been a motivation to combine and a reasonable expectation of success given both publications are in the field of, and solve the problem of railway control for safe maintenance work and both have substantially similar network architecture, among other similarities. EX1004, Abstract, 1, 6, 29, 37-38, Figs. A-1-A4, 2, 4; EX1005, Abstract, ix, 3, 5, 10-12, 16, Figs. 1, 4, Table 2.

168. Thus, a POSITA would have been motivated and had a reasonable expectation of success of modifying Oriol to include Masquelier's mobile device, visual track blocking and unblocking, and text messaging.

169. For instance, a POSITA would have been motivated to modify Oriol to include Masquelier's mobile device because it would provide the worker with

further functionality, including the ability to receive, display, and send text messages.

170. In Oriol, workers “were asked if they would use the PDA in their jobs. Interest was high for both requesting information and work authorizations.” EX1004, 25, 26 (“As one roadway worker said, ‘[The PDA] is an excellent tool for employees working both on the right-of-way and on trains.’”)

171. A POSITA would have had a reasonable expectation of success given Masquelier specifically updated Oriol’s PDA with the “Qualcomm® pdQ™ Smartphone 800” for text messaging (Short Message Service or SMS) relating to work authorization while maintaining the “same tasks” as Oriol. EX1005, 15, 21, 41.

172. A POSITA would also have been motivated to modify Oriol with Masquelier’s central control visual interface for track blocking and unblocking. *Id.*, xi, 37.

173. This would enhance safety because the visual track display would allow the dispatcher in the central control system in Oriol to visually see the tracks blocked and unblocked.

174. It would also improve efficiency because Oriol would simply use the central control system interface to block the track (before transmitting Oriol’s Form

D number to the railway worker) and unblock the track (after receiving the Form D number in return from the railway worker). *Id.*, 10-11, Fig. 1, Table 2.

175. A POSITA would have had a reasonable expectation of success because Oriol includes central control blocking and unblocking based on the Form D number. EX1004, Abstract, 6, 29, 37-38, 41 (“[t]he system is designed to be highly configurable”), Figs. A-1-A4, 2, 4.

176. Also, it was well-known to use a “centralized traffic control” interface for controlling track blocking and unblocking. EX1001, 1:25-47, 1:51-59.

177. Further, a POSITA would have been motivated to modify Oriol with Masquelier’s text message functionality because it would increase efficiency. EX1005, 27 (“dispatchers particularly liked the feature for contacting a roadway worker via SMS”), 21 (“The current hardware platform can use SMS to send and receive messages. . . . • Sending a message by clicking on a roadway worker on the tracking display • Sending an unstructured message to anybody at anytime.”)

178. The railway control apparatus would transmit the Form D number via text message to the worker who could unblock the track by simply responding with their own text message containing the same release code (rather than opening the application in Oriol).

179. The mobile phone's "large touch screen" in Masquelier will also increase efficiency and improve safety because the worker could review and respond to a text message more effectively. *Id.*, 41, 63.

180. A POSITA would have a reasonable expectation of success because SMS "is a globally accepted wireless service that enables the transmission of alphanumeric messages between mobile subscribers and external systems such as web servers, electronic mail, paging, and voice-mail systems" and "is a reliable, low-cost communication mechanism." *Id.*, 63.

181. Additionally, the named inventor acknowledges that mobile phones and text messages were well-known before the Priority Date. EX1023, 2, 8 (¶¶ 5, 7), 15-16.

182. Thus, it was well-known that mobile devices use text and other messaging.

B. Analysis of Independent Claims 1, 5

183. Oriol and Masquelier render obvious claims 1 and 5.

184. As discussed in Oriol, the railway control apparatus generates a release code and transmits it to the worker's electronic contact address. The worker removes the track block by selecting a "Cancel/fulfill" link (Fig. A-1) to transmit the

previously generated Form D number or release code to the railway control apparatus.

185. Oriol could implement Masquelier's mobile device as both devices have overlapping capabilities and implementation would merely require porting the software from one device to another – a routine engineering task.

186. Masquelier teaches that the railway worker accesses a mobile device or smartphone with an “application . . . to request and cancel work authorizations [Form D].” EX1005, 15 (“The Smartphone shown in Figure 2 is a cell phone containing an integrated PDA.”), 16-17, Fig. 4.

187. The mobile phone has a “large touch screen” display. *Id.*, 41.

188. The mobile device and software application (menu) to request and cancel work authorization in Masquelier are shown below:



Figure 2. Qualcomm® pdQ™
Smartphone

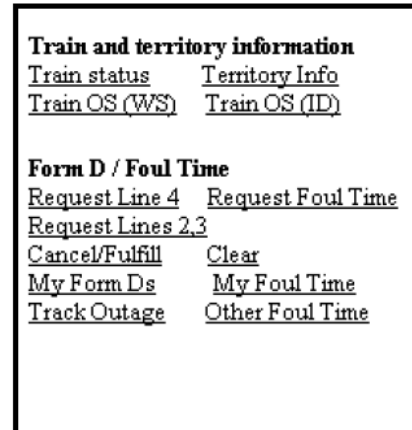


Figure 5. Main Menu

Id., Figs. 2, 5.

189. Oriol could further implement Masquelier’s visual track blocking and unblocking. After receiving the worker’s Form D request, Masquelier teaches that the dispatcher’s railway control apparatus software blocks the track. *Id.*, 11 (“At the Traffic Control Center, the dispatcher could use the track display to protect the track segment in question using software that controlled various switched and signals in the field.”), 10 (“Each dispatcher has a workstation to control the switches and signals.”)

190. This track blocking in Masquelier is shown in Figure 1 below, where the color “Blue” means “a track section is authorized for track maintenance. This means that a portion of track has been protected for use by maintenance of way crews

or track equipment. When the dispatcher gives track authority to a work crew, the dispatcher temporarily loses control over that section of track.” *Id.*, 11.

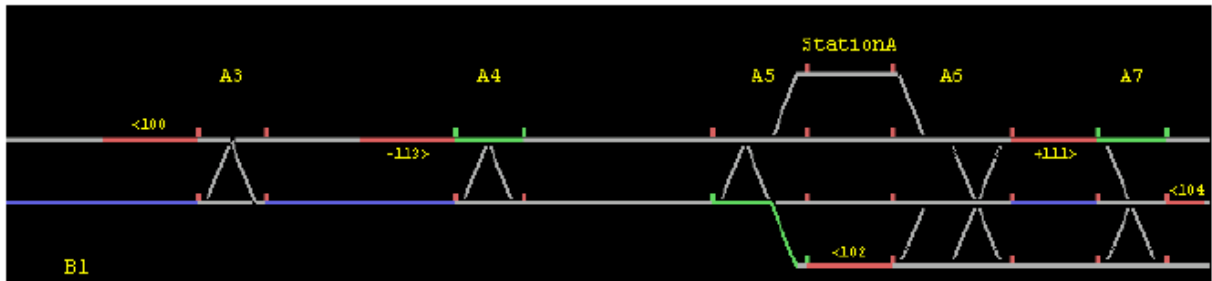


Figure 1. Track Chart Display

Id., Fig. 1 (color-coded display showing tracks blocked (blue) and unblocked).

Table 2. Representation of Color Code for Monitoring Track Status

Color	Meaning
White	Indicates that the track segment is available for routing trains or other uses.
Red	Means train or track vehicle occupancy. A train currently occupies that block.
Green	Indicates that the track segment has been cleared (authorized for use) for train movement. The train has not yet entered this block.
Blue	Indicates that a track section is authorized for track maintenance. This means that a portion of track has been protected for use by maintenance of way crews or track equipment. When the dispatcher gives track authority to a work crew, the dispatcher temporarily loses control over that section of track. Trains cannot enter this track segment unless authorized by the roadway worker responsible for that block.

Id., Table 2 (outlining color meanings).

191. Oriol’s railway control apparatus would generate the Form D number or release code and would implement Masquelier’s text messaging to transmit (using the track display or dispatcher’s phone) that release code to the worker’s phone or electronic contact address.

192. Masquelier specifically updated Oriol's PDA with the "Qualcomm® pdQ™ Smartphone 800" for text messaging relating to work authorization. *Id.*, 15, 21 ("The current hardware platform can use SMS to send and receive messages. . . .
• **Sending a message by clicking on a roadway worker on the tracking display** •
Sending an unstructured message to anybody at anytime.") (emphasis added), 27 ("dispatchers particularly liked the feature for contacting a roadway worker via SMS").

193. SMS "is a globally accepted wireless service that enables the transmission of alphanumeric messages between mobile subscribers and external systems such as web servers, electronic mail, paging, and voice-mail systems." *Id.*, 63.

194. Once the work is completed, the railway worker would simply respond to the prompted text message from the railway control apparatus with a text message containing the same release code to unblock the track. *Id.*, 15 ("exhibited the ability to send and receive short text messages (SMS) . . . [which] enabled the dispatcher or roadway worker to alert each other when a request for track authorization was initiated or answered."), 21, 27, 63. Additionally, the named inventor states that text messaging is well-known, so text messaging could be used with Oriol. EX1023, 2, 8 (¶¶ 5, 7), 15-16.

195. After receiving the release code, the dispatcher's central control software could unblock the track for other uses. *See* Ground 1, claim 1[E]/5[D]; EX1005, Fig. 1 and Table 2, 12 10-12 ("Each dispatcher has a workstation to control the switches and signals. . . . Once the job is complete, the roadway worker returns control of the track to the dispatcher, who releases the track for other uses.")

C. Analysis of Dependent Claims 2-4, 6-8

196. Oriol could use Masquelier's text messaging to send the above cancel/fulfill link in a text message to the railway worker to which the worker would then activate the link to return the release code to the railway control apparatus.

197. A POSITA would have been motivated to make this modification in Oriol because it would provide a more efficient way to unblock the track. The worker would simply select the link to return the release code rather than responding with another text message.

198. A POSITA would have had a reasonable expectation of success given it would be a straightforward modification as links were well-known, such as in webpages or emails, and Oriol transmits links to the worker's PDA software application, so Oriol and Masquelier could reuse the same software to transmit the links with the release code via text message.

199. Alternatively, the link with code could be transmitted and returned via email for the reasons discussed above for text messaging, and email is well-known to a POSITA. EX1023, 2, 8 (¶¶ 5, 7), 15-16.

XIV. GROUND 3: ORIOL AND WISE MAKE CLAIMS 1-8 OBVIOUS

A. Motivation to Combine; Reasonable Expectation of Success

200. A POSITA would have been motivated to modify Oriol with Wise and had a reasonable expectation of success because both references are in the field of, and solve the problem of, railway control for safe maintenance work. EX1004, Abstract, 29, 37, Fig. 2; EX1006, title, Abstract, 1:3-7, 12:6-15.

201. Additionally, there would have been a motivation to combine and reasonable expectation of success because the references involve a substantially similar central railway traffic control. EX1004, Abstract, 1, 6, 29, 37-38, Figs. A-1-A-4, 2, 4; EX1006, 7:33-8:2, 9:23-28, 12:6-15, 24:19-26, 27:22-28:4, claims 1, 16, 17, Figs. 2, 5H, 10.

202. For example, a POSITA would have been motivated to modify Oriol's code generation with Wise's to block the track and thereafter generate a unique access code (*e.g.*, SCN), as the release code.

203. Blocking the track and then generating the code could enhance safety and security as the central control system would only generate the code once the

block has been implemented. This would ensure the code is not unsafely used before the track is blocked, such as to enter the work area.

204. Because Wise's code would be separate from the Form D number, it would be more difficult for a third-party to determine the code and use it to unsafely unblock the track.

205. Wise's code could provide another layer of security over the Form D number because it acts as authority to enter the track for maintenance. EX1006, Abstract, 12:6-15, claims 1, 15-17, 23, 24:19-26, 26:14-23, Fig. 5H.

206. A POSITA would have a reasonable expectation of success because Oriol's railway control apparatus has existing hardware and software (for the Form D number) such that they could block the track and then generate Wise's code. *See* Ground 1, claims 1[B]/5[A]-[D]/5[C].

207. Oriol notes that "[t]he system is designed to be highly configurable," which would further enable a POSITA to make modifications. EX1004, 41.

208. Further, a POSITA would have had a reasonable expectation of success for the worker to transmit the same release code to the railway control apparatus to unblock the track. For example, a POSITA would modify Oriol's "Cancel/Fulfill" in Fig. A-1 to transmit the Wise access or release code with the Form D number to the railway control apparatus.

209. Transmitting the Wise code would require minimal effort or programming because it is simply updating the source code to transmit another value (Wise code) with the Form D number to the railway control apparatus.

B. Analysis of Independent Claims 1, 5

210. Oriol and Wise render obvious claims 1 and 5.

211. After blocking the track, Oriol would generate and transmit Wise's unique access code such as an SCN to be displayed on the worker's device.

212. Wise teaches that, after the worker requests a safety measure, such as a green zone, the central control system blocks the track using signal lights and thereafter generates an access code, *e.g.*, SCN, which is provided to the worker. EX1006, Fig. 5H ("Press the traffic-light icon on the toolbar & the SCN is automatically generated . . . Pass number to COSS [controller of site safety] S553"), 7:33-8:2 ("[G]reen zone refers to a location where there is a blockage such a[s] traffic lights"), claims 1 ("subsequently providing said user with an access code for permitting said user to carry out said service."), 16 ("unique access code is provided to said user"), 17, 30:20-24 ("operators . . . may take steps . . . by controlling traffic lights in the region, controlling the speed of trains or preventing trains from running."), 29:32-30:3 ("operators will be responsible for controlling signalling"), 12:6-15 ("a unique check number, which may be referred to as a safety check number

(SCN), are allocated to the qualified person. This authorises/permits the user and any workmen associated with that user to proceed to carry out work and access a work site. Alternatively the user themselves may not enter the work site.”), 24:19-26, Abstract (“thereafter be allocated a access code number safety can be maintained.”)

213. Wise describes that the access code transmitted to the worker provides authority to enter a track for maintenance. *Id.*, 12:6-15 (SCN “authorises/permits the user . . . to carry out work and access a work site.”), 24:19-26, 26:14-23, 16:16-19, claims 1, 15-17.

214. When the work is completed and “Cancel/Fulfill” is selected, Oriol would transmit the access code (and Form D number) to the railway control apparatus, which would use (or enter) the access code (rather than the Form D number for the reasons discussed above) to unblock the track. *Id.*, 25:4-9 (once the “job is completed . . . the operator [is provided] with the SCN number which has previously been allocated to the job.”); *see* Ground 1, claim 1[E]/5[D].

C. Analysis of Dependent Claims 2-4, 6-8

215. *See* Independent Claims 1/5.

216. The display of “Cancel/Fulfill” in Fig. A-1 is a message such that when activated Wise’s access code would be returned to the railway control apparatus.

217. Alternatively, the code could be transmitted and returned via email or text message as both email and text message are known to a POSITA. EX1023, 2, 8 (¶¶ 5, 7), 15-16; Ground 1, 2-4, 6-8.

XV. GROUND 4: ORIOL MASQUELIER, AND WISE MAKE CLAIMS 1-8 OBVIOUS

218. Oriol, Masquelier, and Wise render obvious claims 1-8. *See* Grounds 2-3.

219. A POSITA would have been motivated to combine Oriol, Masquelier, and Wise and had a reasonable expectation of success given the references are in the field of, and the solve the problem of, railway control for safe maintenance work. EX1004, Abstract, 6, 29, 37-38, Figs. 2, A-1, A-3; EX1005, Abstract, ix, 3, 5, 10-12, 16, Figs. 1, 4, Table 2, 72; EX1006, title, Abstract, 1:3-7, 7:33-8:2, 12:6-15, 24:19-26, 27:22-28:4, 9:23-28, claims 1, 16, 17, Figs. 2, 5H, 10.

220. As discussed previously, a POSITA would have been motivated to modify Oriol and Masquelier to include a central control interface for blocking and unblocking the track as well to transmit and receive the code over text message. *See* Ground 2.

221. A POSITA would have been further motivated to modify this Oriol and Masquelier combination such that the railway control apparatus blocks the track and then uses Wise's access code as the release code instead of the Form D number for

the reasons discussed in Ground 3, including for enhanced safety and security. EX1006, Fig. 5H (“Press the traffic-light icon on the toolbar & the SCN is automatically generated”), claims 1 (“providing said user with an access code”), 16, 17, 12:6-15 (SCN “authorises/permits the user . . . to carry out work and access a work site.”), 24:19-26 (“This number may then be verbally given to the caller at step S553”), 7:33-8:2 (“[G]reen zone refers to a location where there is a blockage such a[s] traffic lights”), 30:20-24 (“operators . . . may take steps . . . by controlling traffic lights in the region, controlling the speed of trains or preventing trains from running.”), 29:32-30:3 (“operators will be responsible for controlling signalling”); *see* Ground 3.

222. When the work is completed and “Cancel/Fulfill” is selected, Oriol and Masquelier would transmit Wise’s access code (and Form D number) to the railway control apparatus, which would use (or enter) the access code (rather than the Form D number for the reasons discussed above) to unblock the track. *See* Ground 1, claim 1[E]/5[D], Grounds 2-3; EX1006, 25:4-9 (transmits the same removal code or “SCN number . . . previously . . . allocated to the job” to the central control system). And there would have been a reasonable expectation of success as previously described since the three references are in a similar field using similar equipment. *See* Grounds 2-3.

**XVI. GROUND 5: ORIOL MASQUELIER, AND PACHL MAKE
CLAIMS 1-8 OBVIOUS**

223. A POSITA would have been motivated to combine Oriol, Masquelier, and Pachl and had a reasonable expectation of success because the references are in the field of, and the solve the problem of, railway control. EX1004, Abstract, 1, 6, 29, 37-38, Figs. A-1-A4, 2, 4; EX1005, Abstract, ix, 3, 5, 10-12, 16, Figs. 1, 4, Table 2; EX1020, 1:33-36, 1:63-66, 2:47-60, 3:22-45, 4:9-15, 4:50-59, Abstract, Figs. 1-2, claim 3.

224. For instance, a POSITA would have been motivated to modify Oriol and Masquelier with Pachl to first block the track and thereafter generate a code.

225. The modification could enhance safety and security as the central control system would only generate the code once the block has been implemented. Such modification would prevent using the release code in an unsafe or incorrect manner before the track is blocked.

226. A POSITA would have a reasonable expectation of success because Oriol and Masquelier could generate a temporary number or other placeholder and then once the safety measure is made effective, generate the Form D number to provide greater security and safety as that release code would not be known until the track is blocked.

227. A POSITA would also have been motivated to modify Oriol and Masquelier with Pachl such that the dispatcher in the railway traffic control apparatus only unblocks the track based on the dispatcher entering the code transmitted from the worker.

228. This code entry would provide another level of protection and confirmation before the track is unblocked. It would also ensure the dispatcher is alert to the information provided, such as unblocking the track.

229. A POSITA further would have had a reasonable expectation of success because Oriol and Masquelier teach a centralized dispatcher user interface and related software that a POSITA could have modified to include entry of the release code. *See* Ground 1, claim 1[B]-[C]; Ground 2.

230. Moreover, because it was known how to enter a code in an interface before permitting train movement (EX1021, 4:10-17, 4:22-27, 4:48-65, 5:24-30, 5:59-65, claim 1, Abstract, Fig. 4), a POSITA would therefore have had a motivation to combine and reasonable expectation of success.

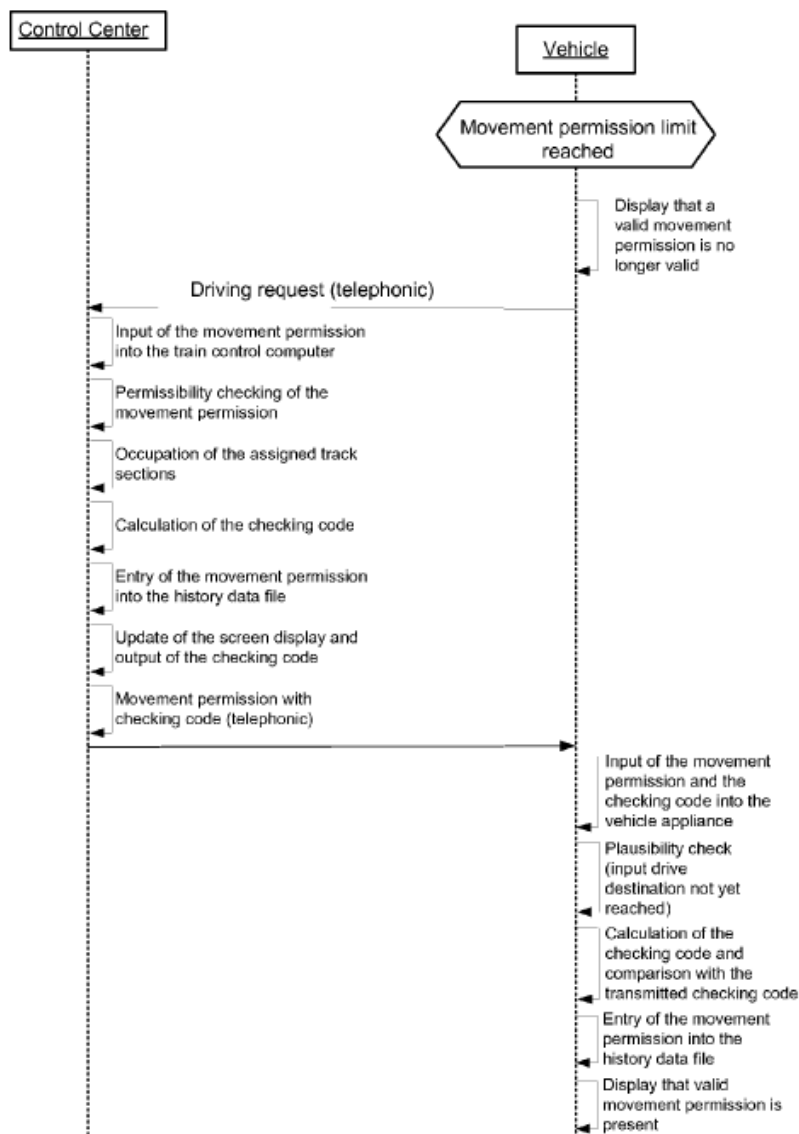
231. Oriol, Masquelier, and Pachl render obvious claims 1 and 5.

232. Oriol and Masquelier could block the track and then generate the code (Form D number) as shown by Pachl first implementing a safety measure and then generating a code.

233. Pachl teaches a central control center with a computer interface to first control the track safety measure (“movement permission”) and then generate a “checking code.” EX1020, 1:33-36, 3:35-40, 4:9-15, 1:38-42, 1:63-66, 3:40-45, 1:11-20, Abstract.

234. Controlling the safety measure (“Permissibility checking of the movement permission” and “Occupation of the assigned track sections”) and then generating the code (“output of the checking code”) is shown in Figure 1 below.

FIG.1

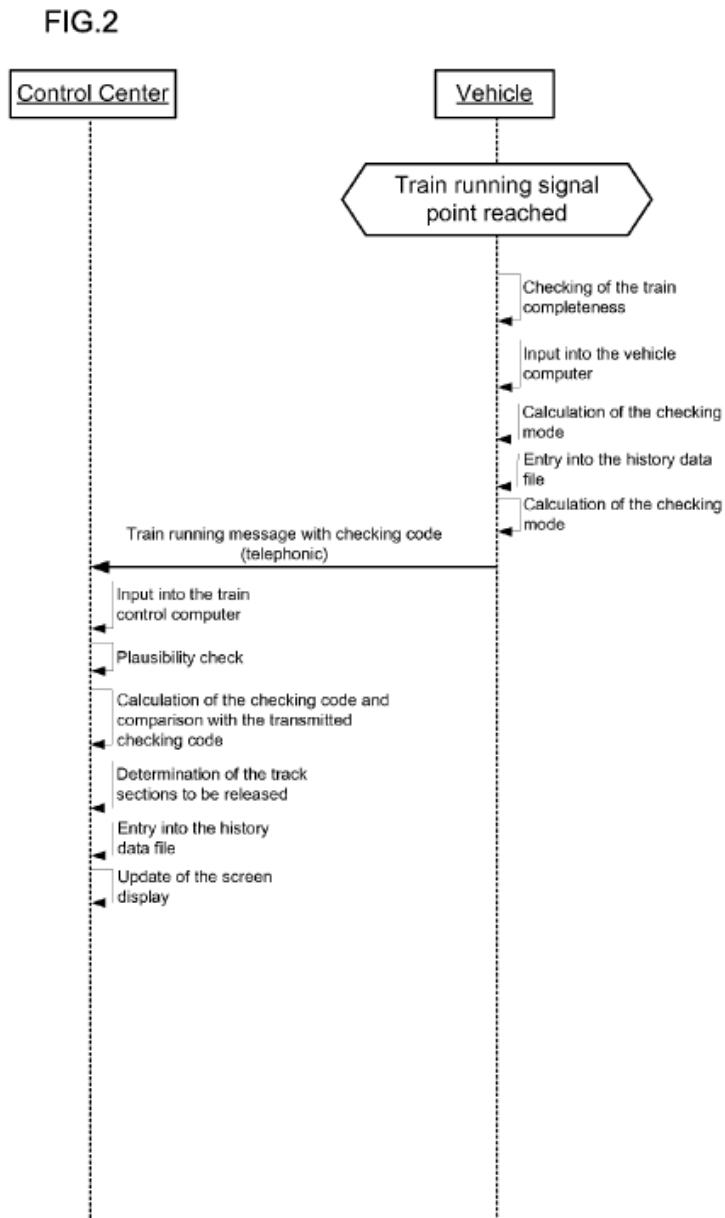


Id., Fig. 1.

235. Oriol and Masquelier could further implement Pachi's entry of a code to release the track.

236. Pachl also teaches that the train controller (such as a dispatcher) at the control center will only release the track upon entry of a received code in the interface. *Id.*, 2:47-60 (“train controller” enters a received code and thus **“it is impossible for an associated track section to be released erroneously.”**) (emphasis added), 4:50-59 (“The train running message and checking code are entered in the train control computer The track sections to be released are then defined and are entered in the history file. The screen display confirms the correctness of the train running message or, if appropriate, signals a fault state.”), 1:63-66, 4:15-18, claims 1, 5.

237. The entering of a code to release the track is shown in Figure 2 below, particularly “Input into the train control computer”:



Id., Fig. 2.

XVII.GROUND 6: TAMARIBUCHI AND PACHL MAKE CLAIMS 1-8 OBVIOUS

A. Motivation to Combine; Reasonable Expectation of Success

238. A POSITA would have been motivated to combine Tamaribuchi and Pchl and had a reasonable expectation of success given the references are in the field of, and the solve the problem of, railway control. EX1007, Abstract, [0002], [0060], [0078]; EX1020, 1:33-36, 1:63-66, 2:47-60, 3:22-27, claim 3.

239. There also would have been a motivation to combine and reasonable expectation of success given that the references implement centralized railway traffic control and utilize a generated code. EX1007, [0060], [0067], [0110], [0118], [0214], [0351], Figs. 1, 3; EX1020, Abstract, 2:47-60, 3:35-45, Figs. 1-2.

240. A POSITA would have been motivated to modify Tamaribuchi with Pchl to first implement the safety measure (such as block the track) and thereafter generate Tamaribuchi's reference number.

241. Blocking the track and then generating the code could enhance safety and security as the central control system would only generate the code once the block has been implemented. This would prevent workers receiving the code from unsafely entering a work area before the track is blocked.

242. A POSITA would have a reasonable expectation of success because Tamaribuchi could generate a temporary number or other placeholder based on the

work order and then once the safety measure is made effective, generate the reference number to provide greater security and safety as discussed above.

B. Analysis of Independent Claims 1, 5

1[Pre]: “A system to enhance railway control, to protect safety of railway workers on or near railway tracks, the system comprising:”

5[Pre]: “A method to enhance railway control, to protect safety of railway workers on or near railway tracks, said method comprising:”

243. Whether or not the preamble is limiting, Tamaribuchi teaches enhanced railway control with a central control system that communicates with a maintenance worker to protect the safety of a railway worker on a track. EX1007, [0002] (“The present invention relates to a control system for controlling a target device having an influence on safety of maintenance work, and a terminal device for maintenance worker and a control device included in the control system.”), [0060] (“The central control device 100 . . . for controlling the rail transportation control system 1”), [0078] (“the area A12 is a display area for a safety measure for the maintenance work, and includes a selection area A121 for items of the safety measure requested by the worker Further, in the area A121, a safety measure option requested by the worker, an option (Track closure required) for making a request to prohibit entry of a train”), Abstract (“central control device controls a target device so that maintenance work is safely performed.”), [0053] (“the rail transportation control

system 1 controls the power control device 910 and the signaling control device 920 in maintenance work so that the maintenance work is safely performed.”)

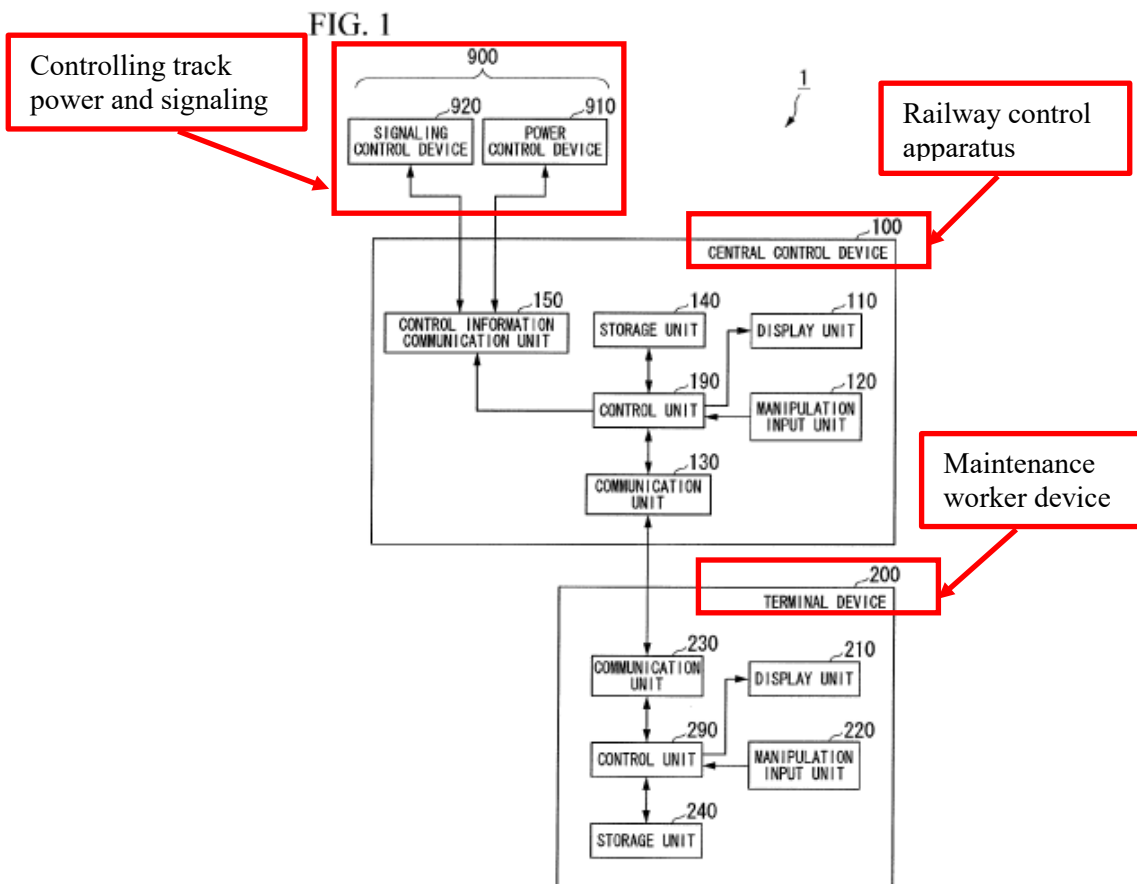
1[A]: “a railway control apparatus comprising a processor, a non-transitory medium storing one or more programs of executable instructions, and a network interface through which the railway control apparatus communicates via a network;”

244. Tamaribuchi teaches the railway control apparatus or central control system with a “control unit” (processor) and “storage unit” having one or more programs of executable instructions. EX1007, [0067] (“The control unit 190 includes a CPU (Central Processing Unit) for reading and executing a program from the storage unit 140 and controls each unit of the central control device 100.”), [0351] (“a program for realizing all or some of the functions of the central control device 100 or the terminal device 200 may be recorded in a computer-readable recording medium. The program recorded in this recording medium may be read and executed with a computer system to perform a process of each unit.”), [0353].

245. The railway control apparatus further includes a “communication unit” for communicating over a network interface with the worker’s maintenance device, such as a PDA. *Id.*, [0063] (“The communication unit 130 performs wireless communication with the communication unit 230 of the terminal device 200.”), [0068] (“The terminal device 200 is, for example, a . . . PDA”), [0071] (“The

communication unit 230 performs wireless communication with the communication unit 130 of the central control device 100.”), [0353].

246. The railway control apparatus also controls the track power and signaling to block and unblock the track. *Id.*, [0054] (“The power control device 910 and the signaling control device 920 are examples of target devices controlled by the central control device 100”). These components are shown below.



Id., Fig. 1 (annotated).

247. Additionally, it was known to a POSITA to use a central control computer to control railway tracks. EX1001, 1:25-2:3.

1[B]: “a user terminal provided to a railway field worker and configured to communicate via the network with the railway control apparatus and to provide a user interface to display information received from the railway control apparatus and to permit the railway field worker to respond to prompts displayed thereon,”

5[A]: “configuring a mobile user device of a railway field worker to provide a device user interface to display information received via a network from a railway control apparatus and to permit the railway field worker to respond to prompts displayed thereon;”

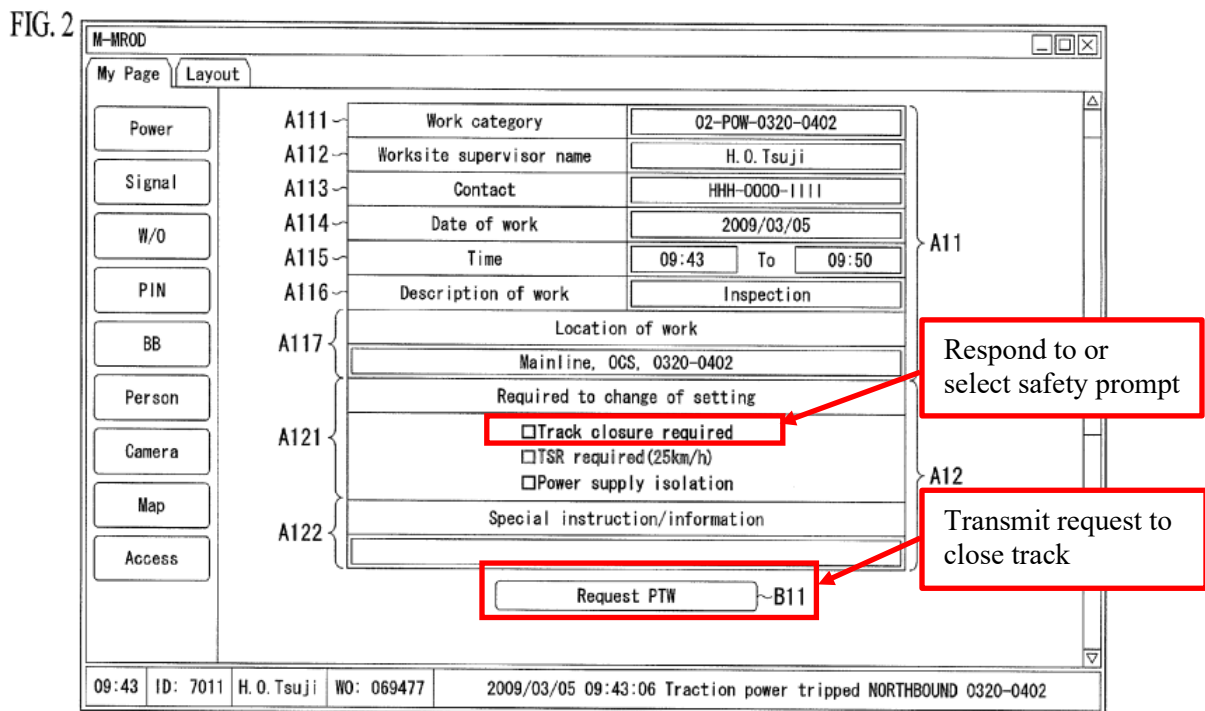
248. Tamaribuchi teaches a railway worker’s user terminal, *e.g.*, PDA, communicating over the Internet with the railway control apparatus. *See* claim 1[A]. A PDA is a mobile device given a PDA is a portable device to communicate over the Internet (or mobile network) and Mr. Pirtle’s statement that mobile phones are well-known. EX1001, 4:47-51, 9:2-5; EX1023, 2, 8 (¶¶ 5, 7), 15-16.

249. The railway control apparatus transmits a work order to display on the PDA. EX1007, [0079] (work order is “a form of an approval request to request approval of the maintenance work and execution of the safety measure”), [0075] (“Fig. 2 [shows] . . . the display unit 210 displays the work order”).

250. The displayed information on the PDA includes prompts for safety measure(s), such as “Track closure required . . . to prohibit entry of a train.” *Id.*, [0078], [0080] (“worker confirms that there is no mistake or deficiency in each item

shown in the area A11 and then selects a necessary safety measure from the items displayed in the area A121.”)

251. “After the worker performs the selection of the safety measure . . . the worker touch[es] a button B11 . . . [to] request for approval (Request PTW)” as shown in Figure 2 below. EX1007, [0082].



Id., Fig. 2 (annotated).

1[C]: “wherein the railway control apparatus, by execution of said one or more programs of executable instructions by the processor, includes: a block placing part to place a block on one or more specified track sections to

permit the railway field worker to enter the track sections while blocking railway traffic to said track sections;”

5[B]: “providing a terminal user interface on a terminal to permit a terminal user of the terminal request the railway control apparatus to place a block on one or more specified track sections to permit a railway field worker to enter the track sections while blocking railway traffic to said track sections;”

252. Tamaribuchi teaches that the user terminal transmits the above approval or blocking request for the safety measure—*e.g.*, track closure—to the railway control apparatus. *See* claim 1[B]/5[A]; EX1007, [0083] (“The communication unit 230 transmits the request for approval output from the control unit 290 to the central control device 100.”), [0089] (“As described in FIG. 2, the safety measure is performed by the central control device 100 when the worker selects items from among the items of the safety measure indicated on the work order and the ordering person approves the selection (accepts the approval request).”), [0064] (“the communication unit 130 transmits the work order to the communication unit 230 and receives the approval request.”), [0123], Fig. 2.

253. As discussed, a POSITA would understand that software would be used to implement the three claimed parts (block placing, code generation, and block removal).

254. Tamaribuchi teaches such software in the railway control apparatus. *See* claim 1[A]; EX1007, [0067], [0351], [0353].

255. After the safety measure request is received, the railway control apparatus' processor executes a block placing part software to block the track by stopping the power and displaying a signal to prohibit train entry. EX1007, [0089] (“[T]he safety measure is performed by the central control device 100 when the worker selects . . . the safety measure”), [0130] (“[T]he **power control device 910 stops power supply to the designated section.** . . . [T]he signaling control device 920 controls the signaling device . . . **to display prohibition of vehicle entry into the designated section**”) (emphasis added), [0131] (“The power control device 910 having completed the process of stopping power supply to the designated section . . . [T]he signaling control device 920 having completed the process of making the signal display indicating vehicle entry prohibition to the designated section”), [0100] (“FIG. 5, a power supply situation in a maintenance work area and the vicinity of the maintenance work area is displayed in an area A41. A state in which power supply is OFF (power supply stops) in a section between × icons C411 and C413 is shown by displaying the × icons C411 and C413 and suppressing display brightness of a route between the × icons. The state in which the power supply is OFF is performed by the central control device 100 controlling the power control device 910.”), Fig. 7, [0055]-[0056], [0127]-[0128].

256. Thereafter, the railway control apparatus “transmits information, indicating that the safety measure is made effective, to the terminal device 200.” *Id.*, [0132].

257. The worker then locks the safety measure (power stopped and signal for vehicle entry prohibited) by transmitting a lock request, including a reference number, to the railway control apparatus. *Id.*, [0135], [0139] (“the control unit 290 generates the request for PIN lock including the reference number”), [0140] (“In the central control device 100, sequence S164 is executed. Specifically, the communication unit 130 receives the request for PIN lock including the reference number corresponding to the work order”)

258. Based on the lock request, the railway control apparatus (control unit) updates the “value . . . for safety measure stored in the storage unit 140, to be ‘lock’” associated with the reference number. *Id.*, [0143]; [0109] (In figure 6, “[e]ach row includes a first column for storing the reference number . . . and a third column and subsequent columns for storing state information for respective safety measures.”) The storage unit’s data structure is shown below in Figure 6:

FIG. 6

WORK ORDER NUMBER	PIN	SAFETY MEASURE 1	SAFETY MEASURE 2	SAFETY MEASURE 3	...
...	...	NOT YET	NA	NOT YET	...
...	...	...	...	...	...

Reference number

"identifying the worker"

Safety measure(s)

Id., Fig. 6 (annotated), [0108], [0111] (“The PIN stored in the second column is an identification number for identifying the worker”).

259. This PIN lock state permits the railway worker to enter the track for maintenance. *Id.*, [0148] (“After confirming that the PIN lock is made effective on the terminal device 200, the worker executes the maintenance work.”), Abstract, [0053] (“the rail transportation control system 1 controls the power control device 910 and the signaling control device 920 in maintenance work so that the maintenance work is safely performed.”), [0057], [0113].

260. Additionally, it was known to a POSITA for central control to transmit a signal to the corresponding interlock to block a track. EX1001, 1:25-2:3.

1[D]: “railway control apparatus . . . includes . . . a code generation part to generate a release code and transmit the release code to an electronic contact address accessible by the railway field worker via operation of the user interface of the user terminal; and”

5[C]: “generating by the railway control apparatus a release code and transmitting the release code to an electronic contact address accessible

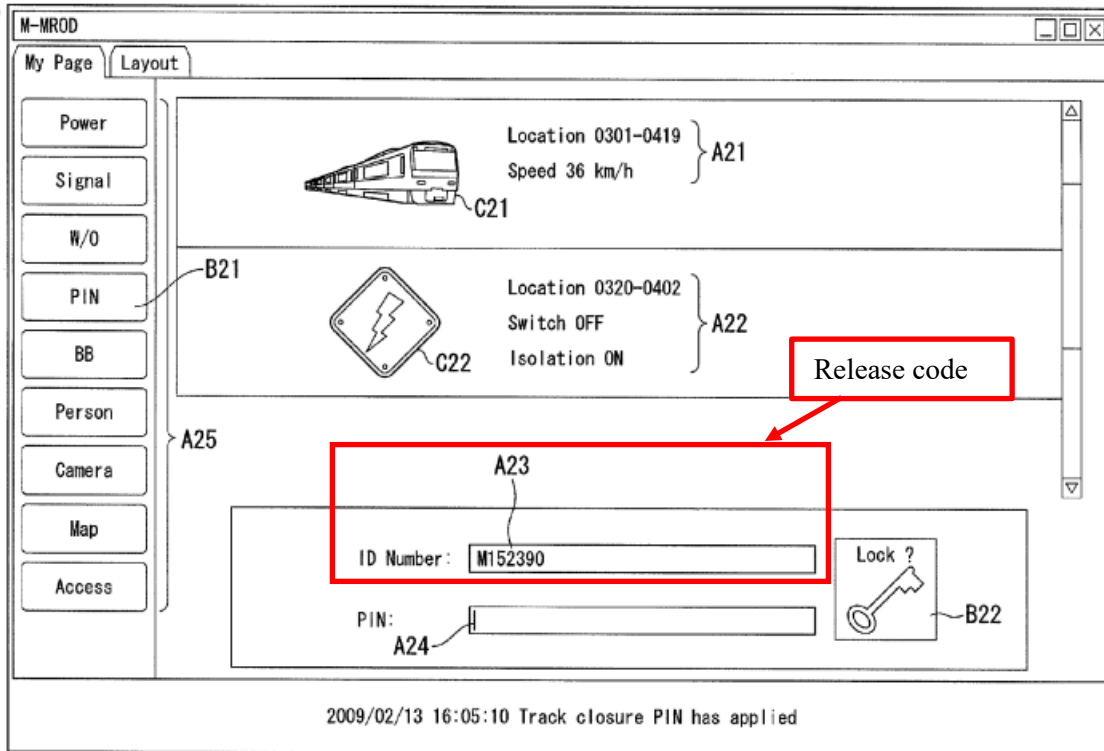
by the railway field worker via operation of the user interface of the user terminal; and”

261. Tamaribuchi teaches the railway control apparatus includes a code generation part (software) which generates a reference number, *e.g.*, serial number, or release code for later unblocking the track. EX1007, [0118] (“control unit 190 produces the work order . . . **adds the reference number . . .**”) (emphasis added), [0110] (“The reference number . . . is an identification number . . . for example, a serial number”), Figs. 3, 4 (A23: “ID Number: M152390”), [0214].

262. The railway control apparatus transmits the reference number to the worker’s electronic contact address because the worker’s “PIN indicates a destination of the work order” and Tamaribuchi shows an example of transmitting to a worker’s phone (“HHH-0000-1111”). *Id.*, [0111], Fig. 2 (A113: “Contact”: “HHH-0000-1111”), [0119] (executes “**communication unit 130 transmits the work order output from the control unit 190, together with the reference number . . . [to] the terminal device 200.**”) (emphasis added), [0215], [0077], Fig. 7.

263. This release code is displayed to the worker on, *e.g.*, a PDA, as shown in Figure 3 (A23) below.

FIG. 3



Id., Fig. 3 (annotated), [0090] (“The reference number corresponding to the work order is displayed in an area A23. . . . [T]he reference number corresponding to the work order is an identification number (ID Number) of the work order. The reference number corresponding to the work order is also used as an identification number of the maintenance work.”), [0088] (Fig. 3 shows “PIN lock is not performed”); Fig. 4, [0094] (Fig. 4 shows “safety measure is PIN-locked”).

264. Tamaribuchi’s reference number (*e.g.*, Figs. 3 or 4: “M152390”), is a release code given the same reference number is used to later release the track block. *Infra* claim 1[E]/5[D].

265. The PIN “is an identification number for identifying the worker [and] indicates a destination of the work order.” EX1007, [0111].

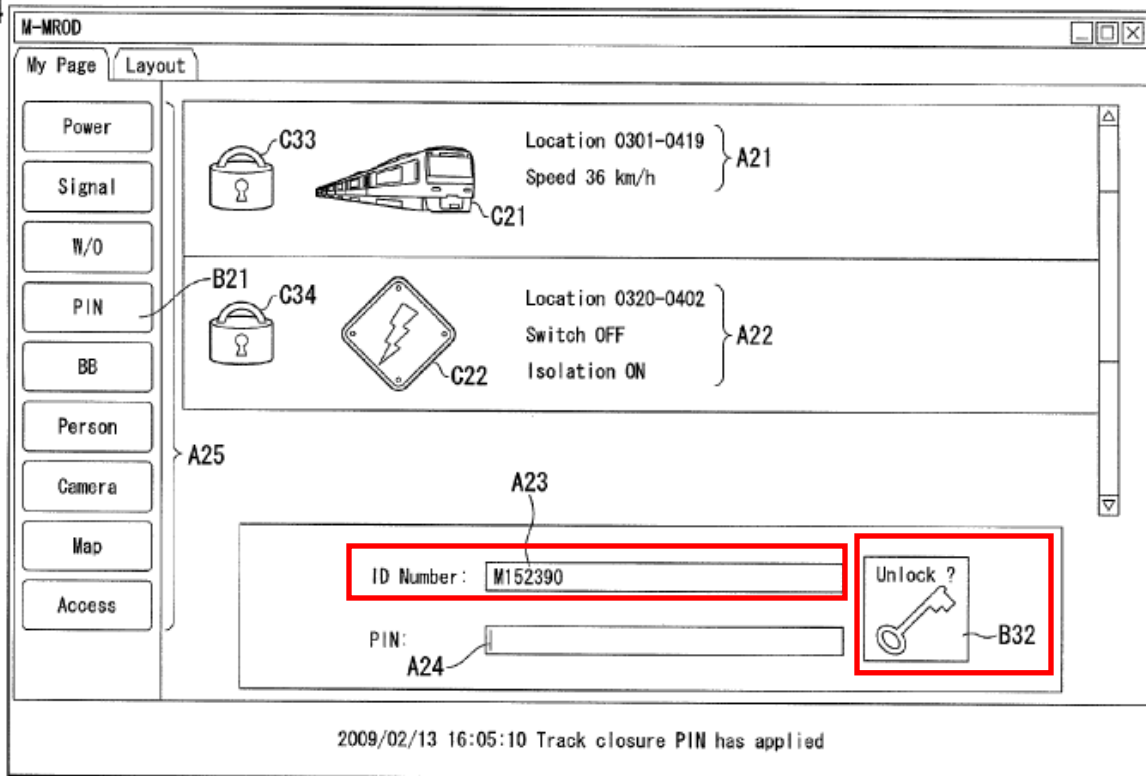
266. To the extent it is argued that claim limitations 1[D] and 5[C] require that the code is generated after the track is blocked, a POSITA as discussed above would have been motivated to modify Tamaribuchi with a reasonable expectation of success to implement Pachl’s central control system to block the track before generating the reference number or release code for greater safety and security. EX1020, 1:11-20, 1:33-36, 1:38-42, 1:63-66, 3:35-40, 3:40-45, 4:9-15, Abstract.

1[E]: “railway control apparatus . . . includes . . . a block removal part to remove only upon receiving the release code from the user terminal in return, the block placed by the block placing part on said one or more track sections.”

5[D]: “permitting the block to said one or more track sections to be removed by the railway control apparatus only upon receiving the release code from the user terminal in return.”

267. To remove the track block, the worker on the PDA interface selects “in FIG. 4, an unlock request button B32 for requesting the release of the PIN lock.” EX1007, [0097].

FIG. 4



Id., Fig. 4 (annotated).

268. This transmits the unlock request, including the same previously generated release code, to the railway control apparatus. *Id.*, [0167] (“control unit 290 **generates a request for PIN lock release** including **the reference number** . . . and the PIN input in sequence S202, and outputs the request for PIN lock release to the communication unit 230.”) (emphasis added), [0168] (“In the central control device 100, sequence S205 is executed. Specifically, the communication unit 130 receives the request for PIN lock release including the reference number corresponding to the work order and the PIN and outputs the request for PIN lock

release to the control unit 190.”), [0321] (“the control unit 290 generates a release request including the reference number corresponding to the work order and the PIN, and outputs the release request to the communication unit 230. The communication unit 230 transmits the release request to the central control device 100.”), [0098].

269. The railway control apparatus, including a block removal part (software), confirms the worker associated with this reference number has authority to remove the track block. *Id.*, [0169] (“the control unit 190 reads a PIN of a person having a right to request PIN lock release . . . **based on the reference number . . . in the request for PIN lock release.**”) (emphasis added).

270. The block removal part then updates the safety measure state associated with the reference number from “Lock” to “Execute” in the storage unit (data structure in Figure 6). *Id.*, [0170] (“The transition to the unlock state is performed by the control unit 190 rewriting the value of the column [in Figure 6] for storing the state information . . . to be ‘Execute.’”), [0109], Fig. 6; *see* claim 1[C]/5[B].

271. Once the safety measure state is changed, the track block will be removed by causing power to be restored and the signaling to be released; otherwise, the central control system “display[s] the reference number . . . at a row whose value is ‘Lock’ . . . [and] that the safety measure cannot be released.” EX1007, [0199], [0200] (“When . . . there is no row whose value is ‘locked,’ . . . the power control

device 910 resumes power supply to the designated section (maintenance work area)”), [0202], [0203].

272. The railway control apparatus then “transmits the information indicating that the safety measure has been released. . . .” *Id.*, [0204].

273. To the extent that the Tamaribuchi reference number must be entered, it would have been obvious to modify Tamaribuchi with Pachl’s code entry to provide confirmation before the track is unblocked and ensure the dispatcher is alert to the information provided from the worker. EX1020, 2:47-60, 4:50-59, 1:63-66, 4:15-18, claims 1, 5, Fig. 2.

274. There would have been a reasonable expectation of success based on Tamaribuchi’s existing centralized control system and related software. *See* claim 1[A].

275. As discussed, it was also known to a POSITA to enter a code. *See* Ground 1, claim 1[E]/5[D]; EX1021, 4:10-17, 4:48-53, 4:54-65, Abstract, 5:24-30, 5:59-65, claim 1, Fig. 4.

C. Analysis of Dependent Claims 2-4, 6-8

Claim 2: “The system of claim 1, wherein upon the railway control apparatus placing the block of railway traffic to said one or more specified track sections and transmitting the release code to the electronic contact address accessible by the railway field worker, the user interface provided on the user terminal displays a message and permits the railway field worker to respond to the message to release the block.”

**Claim 6: “The method of claim 1 5, further comprising:
displaying, upon the railway control apparatus placing the block of railway traffic to said one or more specified track sections and transmitting the release code to the electronic contact address accessible by the railway field worker, a message through the device user interface provided on the mobile user device and permitting the railway field worker to respond to the message to release the block.”**

276. Tamaribuchi teaches the railway control apparatus, including the block placing part, blocks the track section and transmits the release code to the worker’s PDA electronic contact address. *See* claim 1[D]/5[C].

277. Tamaribuchi also teaches that the worker’s user terminal displays a message showing the code, *e.g.*, a text box with the reference number. *See Id.*; EX1007, Fig. 4 (A23: “ID Number: M152390”), [0090].

278. The worker responds to the message by pressing the displayed unlock button, as shown in Figure 4 above, which returns the release code to the railway control apparatus. *See* claim 1[E]/5[D]; EX1007, [0165], [0167], [0168], [0321].

279. Alternatively, a POSITA would have been motivated to modify Tamaribuchi to transmit the reference number in an email or text message to the worker and have the worker return the release code in an email or text message to the railway control apparatus because it could provide a more accessible and efficient form for communication.

280. There would have been a reasonable expectation of success as Tamaribuchi teaches the worker emailing the railway control apparatus with a lock release and thus a POSITA would have existing software in which to make the modification. EX1007, [0181]-[0183], [0306].

281. There is also a motivation to combine and reasonable expectation of success based on Mr. Pirtle's statement discussed previously. EX1023, 2, 8 (¶¶ 5, 7), 15-16.

282. Once the reference number is transmitted to the railway control apparatus, the track section is released. *See* claim 1[E]/5[D].

Claim 3: "The system of claim 2, wherein upon the railway field worker responding to the message to release the block, the release code is returned to the railway control apparatus."

**Claim 7: "The method of claim 6, further comprising:
upon the railway field worker responding to the message to release the block, returning the release code to the railway control apparatus."**

283. *See* claims 2/6.

Claim 4: "The system of claim 2, wherein the message displayed by the user interface on the user terminal includes an embedded link for activating a return transmission of the release code to the railway control apparatus."

Claim 8: "The method of claim 2 7, wherein the message displayed by the device user interface on the mobile user device includes an embedded link for activating a return transmission of the release code to the railway control apparatus."

284. Tamaribuchi teaches an embedded link with an unlock button (“Unlock ?” in Figure 4). *See* claims 2/6; EX1007, [0165], [0167].

285. It would have been known to a POSITA to change a button to a link as links and buttons in webpages, for instance, are well-known and are simply one of a finite number of design choices.

286. Alternatively, a POSITA would have been motivated to transmit the “Unlock ?” as an embedded link in an email or text message because it would provide a simpler (efficient) mechanism to return the release code.

287. A POSITA would have a reasonable expectation of success because embedded links are known and email and text are known communication methods. EX1023, 2, 8 (¶¶ 5, 7), 15-16.

288. When the link is activated, it transmits the reference number or release code to the railway control apparatus to release the track block. *See* claims 2/6, 1[E]/5[D].

XVIII.GROUND 7: WISE AND MASQUELIER MAKES CLAIMS 1-8 OBVIOUS

A. Motivation to Combine; Reasonable Expectation of Success

289. A POSITA would have been motivated to modify Wise with Masquelier because both references are in the field of, and the solve the problem of,

railway control for maintenance work. EX1006, title, Abstract, 1:3-7, 12:6-15; EX1005, Abstract, 3, 10-12, 16, Fig. 4

290. A POSITA would further have been motivated to modify Wise with Masquelier's central control track blocking and unblocking to enhance safety.

291. The visual track display would allow the Wise operator (dispatcher) to visually analyze the tracks blocked and unblocked. This could improve safety and thus improve overall safety because the dispatcher could decide in real-time which tracks to block and unblock tracks. EX1005, xi ("Auditory communications were more prone to errors because their transient nature placed higher memory demands on the dispatcher."), 37.

292. It would also improve efficiency because the operator could simply select a track on the interface to block the track (after receiving a worker's request) or unblock the track (after receiving the release code from the worker). *Id.*, 10-11, Fig. 1, Table 2.

293. Also, a POSITA would have been motivated to modify Wise with Masquelier's mobile device using text message communication because such functionality would improve safety for both the worker and central control dispatcher.

294. Masquelier would enable the Wise worker to receive, display, and respond to the release code as opposed to in Wise where the worker and dispatcher may receive the access code orally which could be forgotten or lost. EX1006, 24:19-26, 25:4-9, claim 1, Fig. 5H, 32:10-13; EX1005, xi, 37.

295. A POSITA would have had a reasonable expectation of success given mobile devices, including text messaging, were well-known and Masquelier explains “dispatchers particularly liked” text messaging. EX1005, 27, 21, 63; EX1023, 2, 8 (¶¶ 5, 7), 15-16.

B. Analysis of Independent Claims 1, 5

1[Pre]: “A system to enhance railway control, to protect safety of railway workers on or near railway tracks, the system comprising:”

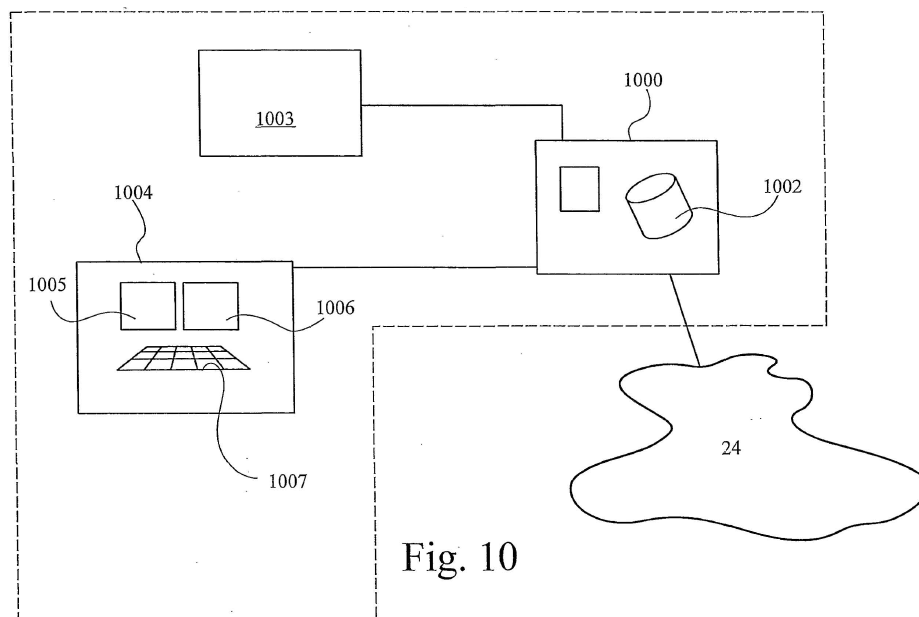
5[Pre]: “A method to enhance railway control, to protect safety of railway workers on or near railway tracks, said method comprising:”

296. Whether or not the preamble is limiting, Wise teaches to enhance railway control by protecting worker safety using an access code. EX1006, 1:3-7 (“invention relates to a method for improving safety of personnel working at a work site which may be part of a rail network.”), Abstract (“thereafter be allocated a access code number safety can be maintained. The invention is particularly advantageous when workers must access a work site to carry out work under a safe system of work.”), Title (“Safety check”), claims 1 (“A method for increasing safety at a work

site . . . subsequently providing said user with an access code for permitting said user to carry out said service.”), 16, 17, 12:6-15 (code “authorises/permits the user . . . to carry out work and access a work site.”), 10:1-6, 25:4-9.

1[A]: “a railway control apparatus comprising a processor, a non-transitory medium storing one or more programs of executable instructions, and a network interface through which the railway control apparatus communicates via a network;”

297. As shown in Figure 10 below, Wise teaches central control (remote station / call center 21) or railway control apparatus with a processor 1000 and associated databases, a display 1003, and an operator (dispatcher) terminal 1004 that communicates over a network interface (Internet) with a worker’s mobile terminal 20.



EX1006, Fig. 10, 27:22-28:4 (“Figure 10 illustrates a remote location such as a call centre 21 . . . [including] one or more servers 1001 and associated databases . . . [and] processor 1000”).

298. Figure 2 is provided below.

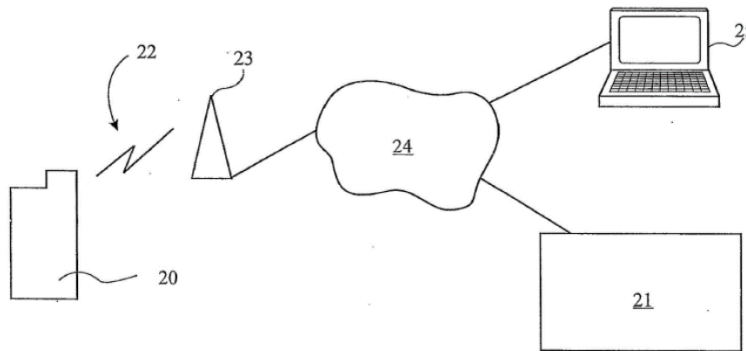


Fig. 2

Id., Fig. 2, 9:23-28 (“Figure 2 illustrates the remote access system. The assessor user uses a mobile terminal 20 to call a remote station 21 . . . [which] are connected via . . . the internet 24.”)

299. The one or more servers and associated databases would each have a non-transitory medium such as a hard drive or other storage for “storing one or more programs of executable instructions” because the central control system would have software to control the track signal lights (and other equipment) and then generate a release code. *Id.*, Fig. 5H (“Press the traffic-light icon on the toolbar & the SCN is automatically generated”), 24:19-26 (“This number may then be verbally given to the caller at step S553”), claims 1, 16, 17, 30:19-24 (“[central control] operators . . .

may take steps to modify parameters at that work site. For example by controlling traffic lights in the region”), Abstract, Fig. 6A.

300. Nevertheless, Wise could implement Masquelier’s central control system software for visual track blocking and unblocking, as discussed in claim 1[C]/5[B]. EX1005, 10, 11, Table 2, Fig. 1.

301. Additionally, it was known to a POSITA to use a central control computer to control railway tracks. EX1001, 1:25-2:3.

1[B]: “a user terminal provided to a railway field worker and configured to communicate via the network with the railway control apparatus and to provide a user interface to display information received from the railway control apparatus and to permit the railway field worker to respond to prompts displayed thereon,”

5[A]: “configuring a mobile user device of a railway field worker to provide a device user interface to display information received via a network from a railway control apparatus and to permit the railway field worker to respond to prompts displayed thereon;”

302. Wise teaches a railway worker using a mobile terminal to communicate via a network with a railway control apparatus. *See* claim 1[A]; EX1006, 9:23-28; 26:2-4. Wise’s mobile device displays information. EX1006, claim 19.

303. Wise could implement Masquelier’s mobile device because it would enable the worker to receive and send text messages with the railway control apparatus. EX1005, 15, 21, 63.

304. The worker can respond to such displayed text messages by transmitting messages back to the central control dispatcher. *see also Id.*

1[C]: “wherein the railway control apparatus, by execution of said one or more programs of executable instructions by the processor, includes: a block placing part to place a block on one or more specified track sections to permit the railway field worker to enter the track sections while blocking railway traffic to said track sections;”

5[B]: “providing a terminal user interface on a terminal to permit a terminal user of the terminal request the railway control apparatus to place a block on one or more specified track sections to permit a railway field worker to enter the track sections while blocking railway traffic to said track sections;”

305. As discussed, software would implement the three parts in claim 1.

306. Wise teaches such software in the railway control apparatus. *See* claim 1[A].

307. Wise teaches that the railway worker uses the mobile phone to request the railway control apparatus to block the track, *e.g.*, a green zone. EX1006, Fig. 5H, 7:33-8:2, 17:4-6, 21:4-5.

308. After the blocking request is received, the railway control apparatus' block placing part (software) implements the green zone (blocking) by controlling the signal lights to prevent trains from entering. *Id.*, Fig. 5H (“**Press the traffic-light icon** on the toolbar”) (emphasis added), 7:33-8:2 (“[G]reen zone refers to a location where there is a blockage such a[s] traffic lights”), 30:19-24 (“operators . . . may

take steps . . . by controlling traffic lights in the region, controlling the speed of trains or preventing trains from running.”), 29:32-30:3 (“operators will be responsible for controlling signalling”), 13:26-27, 23:10-16.

309. Wise could implement Masquelier’s visual track blocking (block placing part 1[C]) and unblocking (block removal part 1[E]) software as both systems are similar, using similar components, and such a modification would merely be a routine engineering task.

310. Masquelier describes that the dispatcher’s railway control apparatus software blocks the track after receiving such a request from the worker. EX1005, 11 (“dispatcher could use the track display to protect the track segment in question using software that controlled various switched and signals”), 10, Fig. 1, Table 2.

311. The blocked track permits the railway worker to enter the track to perform, *e.g.*, maintenance work. *See infra* claim 1[D]/5[C]; EX1005, Table 2 (“Blue” means “a track section is authorized for track maintenance.”), Fig. 1, 11-12.

312. Additionally, it was known to a POSITA for central control to transmit a signal to the corresponding interlock to block a track. EX1001, 1:25-2:3.

1[D]: “railway control apparatus . . . includes . . . a code generation part to generate a release code and transmit the release code to an electronic

contact address accessible by the railway field worker via operation of the user interface of the user terminal; and”

5[C]: “generating by the railway control apparatus a release code and transmitting the release code to an electronic contact address accessible by the railway field worker via operation of the user interface of the user terminal; and”

313. After blocking the track, Wise teaches the railway control apparatus, including its code generation part (software), generates an access code, such as an SCN, or release code. EX1006, Fig. 5H (“Press the traffic-light icon on the toolbar & the SCN is automatically generated”), 24:19-26, Claims 1, 16, 17 (“unique access code”), Abstract, Fig. 6A.

314. This code is transmitted to the worker. *Id.*, 12:6-15 (“a unique check number [SCN] . . . [is] allocated to the qualified person.”), 24:19-26 (“This number may then be verbally given to the caller at step S553”), Fig. 5H, Abstract, claims 1 (“subsequently providing said user with an access code for permitting said user to carry out said service.”), 16, 17.

315. As discussed, a POSITA would have been motivated to modify Wise with Masquelier to transmit the release code over text message to the worker’s phone or electronic contact address. EX1005, 15, 21, 27, 63.

316. Upon receiving the release code, the worker can safely enter the worksite for maintenance. EX1006, 12:6-15 (code “authorises/permits the user . . .

to carry out work and access a work site.”), 24:19-26, 10:4-6, claim 17 (“The apparatus as claimed in claim 16 wherein said unique access code provides a permit for said user to access said work site.”)

1[E]: “railway control apparatus . . . includes . . . a block removal part to remove only upon receiving the release code from the user terminal in return, the block placed by the block placing part on said one or more track sections.”

5[D]: “permitting the block to said one or more track sections to be removed by the railway control apparatus only upon receiving the release code from the user terminal in return.”

317. Wise teaches when the work is completed, the worker transmits the same SCN “previously . . . allocated to the job” to the railway control apparatus to release the work. EX1006, 25:4-9, Fig. 5H (“Ask for SCN”).

318. As discussed, a POSITA would have been motivated to modify Wise with Masquelier such that the worker transmits a text message with a release code (in response to the received text message containing the release code) to the railway control apparatus to unblock the track.

319. Upon receiving the Wise release code, the railway control apparatus would then use Masquelier’s visual track unblocking or block removal part (software) to unblock the track. EX1005, 12, 10-11, Fig. 1, Table 2.

320. To the extent the code must be entered, it was known to a POSITA to enter the received code to ensure the operator is alert to the information provided. EX1021, 4:10-17, 4:48-53, 4:54-65, Abstract, 5:24-30, 5:59-65, claim 1, Fig. 4.

321. This text message modification would improve safety because Wise's oral code could be forgotten or lost and would reduce delay as Wise's phone line could be busy when the worker calls the railway control apparatus to orally provide the release code.

C. Analysis of Dependent Claims 2-4, 6-8

Claim 2: "The system of claim 1, wherein upon the railway control apparatus placing the block of railway traffic to said one or more specified track sections and transmitting the release code to the electronic contact address accessible by the railway field worker, the user interface provided on the user terminal displays a message and permits the railway field worker to respond to the message to release the block."

Claim 6: "The method of claim 1 5, further comprising:

displaying, upon the railway control apparatus placing the block of railway traffic to said one or more specified track sections and transmitting the release code to the electronic contact address accessible by the railway field worker, a message through the device user interface provided on the mobile user device and permitting the railway field worker to respond to the message to release the block."

322. Wise and Masquelier describe that the railway control apparatus includes a code generation part that generates an access code and transmits that release code over text message to the worker's mobile phone (electronic contact address). *See* claim 1[B]/5[A], 1[D]/5[C].

323. The worker would respond to such text message by transmitting the release code back to the railway control apparatus. *See* claim 1[E]/5[D].

Claim 3: “The system of claim 2, wherein upon the railway field worker responding to the message to release the block, the release code is returned to the railway control apparatus.”

Claim 7: “The method of claim 6, further comprising:

upon the railway field worker responding to the message to release the block, returning the release code to the railway control apparatus.”

324. *See* claims 2/6, 1[E]/5[D].

Claim 4: “The system of claim 2, wherein the message displayed by the user interface on the user terminal includes an embedded link for activating a return transmission of the release code to the railway control apparatus.”

Claim 8: “The method of claim 2 7, wherein the message displayed by the device user interface on the mobile user device includes an embedded link for activating a return transmission of the release code to the railway control apparatus.”

325. *See* claims 2/6.

326. A POSITA would have been motivated to modify the transmitted text to display the release code as a link such that activating the link returns the code to the railway control apparatus. *See* claims 1[B]/5[A], 1[E]/5[D].

327. Transmitting the code based on selecting a link would improve the efficiency for railway workers as they would simply select a link and there would

have been a reasonable expectation of success as it was known how to create links in software to return data, such as a release code.

XIX. CONCLUSION

328. The findings and opinions set forth in this declaration are based on my work and examinations to date.

329. I may receive additional documentation and other factual evidence over the course of this IPR that will allow me to supplement and/or refine my opinions.

330. I reserve the right to add to, alter, or delete my opinions and my declaration upon discovery of any additional information.

331. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code, and may jeopardize the validity of the application or any patent issuing thereon.

Declaration of William R. Michalson
U.S. Patent No. 9,517,782

July 6, 2023



William R. Michalson, Ph.D

Exhibit A

Curriculum Vitae for William R. Michalson

Research Associates, LLC
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Douglas, MA 01516
Email: wrm@wmichalson.com
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; also holds collaborative appointments as a Professor of Computer Science, a Professor of Mechanical Engineering and a Professor of Robotics Engineering.

Effective Sep, 2016 Granted a collaborative appointment as a Professor of Mechanical Engineering.

Effective July 1, 2005 Promoted to the rank of Full Professor (Professor of Electrical and Professor of Computer Science)

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

Geoscope Technologies Pte. Ltd. V. Google LLC

Retained by William & Connolly LLP on behalf of defendant Google. Case before the United States District Court for the Eastern District of Virginia (Case No. 1:22-cv-01331-MSN-IDD). Retained 2/23.

American Patents, LLC v. Texas Instruments, Inc., Realtek Semiconductor Corporation and Mediatek Inc.

Retained by Texas Instruments, Realtek, and Mediatek as an expert on defendants. Case before the United States District Court for the Eastern District of Texas – Sherman Division (Case Nos. 4:22-cv-478, 4:22-cv-479, and 4:22-cv-480). Declaration with respect to claim construction 2/10/23). Retained 1/23.

Volvo Penta of the Americas, LLC. v. Brunswick Corporation

Retained by Kilpatrick Townsend & Stockton, LLP as an expert on behalf of petitioner Volvo Penta. Provided declarations in support of multiple IPR filings (IPR2022-01366, IPR2022-01367, IPR2022-01368, IPR2022-01369, and IPR2022-01424). Retained 6/22.

Textron Innovations INC. v. SZ DJI Technology Co, LTD. and DJI Europe B.V.

Retained by Baker Botts, LLP as an expert on behalf of plaintiff Textron. Case before the United States District Court for the Western District of Texas (Case No. 6:21-cv-00740-ADA). Retained 2/22 – 4/23, Deposed 1/22/23 and 1/24/23, Testified 4/17-18.

Smartsky Networks, LLC, v. GOGO Business Aviation, LLC and GOGO INC.

Retained by Sidley Austin, LLP as an expert on behalf of defendant Gogo. Case before the United States District Court for the District of Delaware (Case No. 22-266 UNA). Deposed 5/19/22. Retained 3/22.

Via Transportation, Inc. v. RideCo Inc.

Retained by Erise, IP on behalf of defendant RideCo. Case before the United States District Court for the Western District of Texas, (Case No. No. 6:21-cv-00457). Retained 1/22.

BillJCo, LLC v. Cisco Systems, Inc., Apple Inc., Hewlett Packard Enterprise Co. and Aruba Networks, LLC

Retained by the law firms of Merchant & Gould, P.C., DLA Piper, and Greenberg Traurig, LLP Purpose on behalf of their clients Cisco Systems, Inc., Apple Inc., Hewlett Packard Enterprise Co. and Aruba Networks, LLC for the analysis of certain patents relating to methods and systems for location tracking of mobile devices. Submitted declaration related to IPR2022-420 and IPR2022-00427. Retained 12/21.

Mark Adams, Sr., v. Cataldo Ambulance Service, Inc,

Retained by Morrisson Mahoney, LLP on behalf of defendant Cataldo Ambulance Service. Case before Middlesex Superior Court, Commonwealth of Massachusetts, Civil Action No. 19-CV-1931. Retained 10/21.

Omnitracs, LLC et al. v. Platform Science, Inc.

Retained by Fish & Richardson on behalf of defendant Platform Science, Inc. Case before the Federal District Court Southern District of California. Case No. 3:20-cv-0958-JS-MDD. Retained 8/21.

LoganTree, LP v. Garmin International, Inc. and Garmin USA, Inc.

Retained by EriselP on behalf of defendant Garmin. Case before the District of Kansas, Case No. 17-cv-01217 2:16-cv-190 involving U.S. Patent No. 6,059,576. Submitted Expert Report on Non-Infringement; Deposed 12/1/21; Testified in Court 10/26/22; Retained 7/21 - 10/22.

Allstate Insurance Company V. Atos, LLC

Retained by Sidley Austin, LLP on behalf of petitioner Allstate Insurance Company challenging the validity of US Patent Nos. 8,527,140; 9,152,609; and 9,846,174 at the Patent Trial and Appeal Board of the U.S. Patent Office. Submitted declarations in IPR2021-01118, IPR2021-01209, and IPR2021-01449. Deposed 3/31/22 and 4/7/22; Retained 2/21.

R&R Packaging, Inc. D/B/A R&R Solutions v. Evenflo Company, Inc.

Retained by Polsinelli on behalf of Plaintiff R&R. Case before the Western District of Arkansas (Fayettevill Division), Case No. 5-20-cv-05095. Submitted Reports on Claim Construction; Deposed 7/21; Retained 11/20.

InfoGation Corporation v. Google LLC.

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 Southern District of California, San Diego Division (Case No. 3:21-CV-00843-H-JLB). Deposed 2/27/13 - 2/28/13. Retained 8/20 to 6/22.

WSOU Investments LLC v. Dell Technologies Inc. et al.

Retained by Gibson-Dunn on behalf of defendant Dell. Case before the United States District Court for the Western District of Texas, (Case Nos. 20-cv-00473-ADA; 20-cv-00474-ADA; 20-cv-00475-ADA; 20-cv-00476-ADA; 20-cv-00477-ADA; 20-cv-00478-ADA; 20-cv-00479-ADA; 20-cv-00482-ADA). Deposed 5/11/23. Retained 7/20. Case currently stayed.

Apple v. LBS Innovations, LLC.

Retained by EriselP on behalf of petitioner Apple, Inc., challenging the validity of U.S. Patent No. 6,091,956 at the Patent Trial and Appeal Board of the U.S. Patent Office, IPR2020-00696. Retained 02/20. Submitted declaration.

Makor Issues & Rights Ltd. v. Google LLC et al.

Retained by Arnold & Porter Kaye Scholer LLP on behalf of defendant Google. Case before the District of Delaware, Case No. 1:16-cv-00100. Retained 12/19.

Intellectual Ventures I, LLC and Intellectual Ventures II, LLC v. NetApp, Inc.

Retained by Gibson Dunn on behalf of defendant NetApp, Inc. Case before the District of Massachusetts, Case No. 1:16-cv-10868-PBS. Retained 09/19. Submitted Expert Reports on Invalidity and Non-Infringement.

Google, LLC v. Traxcell Technologies, LLC.

Retained by Finnegan, Henderson, Farabow, Garrett & Dunner, LLP on behalf of petitioner Google, Inc., challenging the validity of U.S. Patent Nos. 9,918,196 and 10,820,147 at the Patent Trial and Appeal Board of the U.S. Patent Office, IPR2021-01004 and IPR2022-00442. Retained 06/18. Submitted declarations.

Lipton, et al. v. Knight, et al.

Retained by Campbell Conroy & O'Neil, PC on behalf of defendant First Student. Case before the Superior Court of Massachusetts, Plymouth, Case No. PLCV 2014-00528. Retained 05/19-8/19. Submitted Expert Disclosure.

PPS Data, LLC., v. Jack Henry & Associates, Inc.

Retained by Polsinelli on behalf of defendant Jack Henry and Associates. Case before the Eastern District of Texas. Retained 11/18-9/19. Submitted Expert Reports on Invalidity and Non-Infringement; Deposed 5/29/19, testified in Court 9/11/19.

Cisco Systems, Inc. v. TracBeam, LLC.

Retained by Haynes Boone, LLP on behalf of petitioner Google, Inc., challenging the validity of U.S. Patent Nos. 7,525,484 9,277,525, and 7,298,327 at the Patent Trial and Appeal Board of the U.S. Patent Office, IPR2018-01722 - IPR2018-01728. Retained 06/18. Submitted declarations.

Burriss Company, Inc. v. Garmin International, Inc.

Retained by Shook Hardy and Bacon on behalf of defendant Garmin. Case before the District of Oregon, Case No. 6:18-CV-00700. Submitted Declaration wrt Invalidity; Testified in Court (PI hearing) 07/11/18; Retained 04/18-08/18.

American GNC Corporation v. LG Electronics Inc., LG Electronics Mobilecomm U.S.A., Inc., and LG Electronics Mobile Research U.S.A., LLC.

Retained by White & Case on behalf of defendant LG. Case before the Southern District of California, Case No. 3:17-CV-01090-BAS-BLM. Retained 11/17. Submitted Declaration wrt Claim Construction; Deposed 1/18.

Qualcomm v. Apple

Retained by Quinn-Emanuel on behalf of plaintiff Qualcomm. Case before the Southern District of California, Case Nos. 3:17-cv-00108-GPC-MDD and 3:17-cv-01010-GPC-MDD. Retained 10/17-5/19; Submitted Expert Report; Deposed 10/18.

Samantha Ingram v. New England Beauty Academy, LLC a/k/a Toni&Guy Hairdressing Academy, Newell Rubbermaid INC. and Goody Products, INC. d/b/a Solano.

Retained on behalf of plaintiff Samantha Ingram. Case before the Worcester Superior Court, Commonwealth of Massachusetts, Civil Action 1385CV02129D. Retained 09/17-09/18; Submitted Expert Disclosure.

FISERV, INC., Jack Henry & Associates, Inc., Q2 Software, Inc., American National Bank of Texas and Hanmi Bank, Petitioners v. Mirror Imaging LLC., Patent Owner.

Retained by Polsinelli on behalf of petitioners to provide declarations for multiple petitions for covered business methods review. See CBM2018-00012, CBM2018-00014, and CBM2018-00015. Retained 1/18-03/18.

Acceleron v. Dell Inc.

Retained by Baker Botts on behalf of defendant Dell. Case before the Northern District of Georgia, Case No. 1:12-cv-04123-TCB. Submitted Expert Reports related to Claim Construction, Invalidity

and Non-Infringement; Deposed 10/13/17 and 6/20/19; Trial 9/6/21 to 9/17/21; Retained 7/17 to 9/21.

Omega Patents, LLC v. CalAmp Corp.

Retained by Sidley Austin on behalf of defendant CalAmp. Case before the Middle District of Florida, Case No. 6:13-cv-1950 involving U.S. Patent Nos. 6,346,876; 6,756,885; 7,671,727 and 8,032,278. Retained 5/17 to 12/17.

Unified Patents, Inc.

Retained by Unified Patents to provide declarations for multiple petitions for *inter partes* review related to patents U.S. Patent No. 7,650,234 and 8,538,498. Retained 03/17-05/17.

Garmin Switzerland GmbH, and Garmin Corporation v. Navico Inc., C-MAP USA, Inc., and C-MAP/Commercial, Ltd.

Retained by Shook, Hardy & Bacon, L.L.P. on behalf of plaintiff Garmin. Case before the District of Kansas, Case No. 16-cv-2706 involving U.S. Patent Nos. 7,268,703 and 6,459,987. Submitted Declaration On Claim Construction; Deposed 12/21/17; Retained 10/16 to 02/18.

Navico Inc. and Navico Holdings AS, v. Garmin International, Inc. and Garmin USA, Inc.

Retained by Paul Weiss on behalf of defendant Garmin. Case before the Eastern District of Texas, Case No. 2:16-cv-190 involving U.S. Patent Nos. 9,223,922 and 9,244,168. Submitted Expert Report on Non-Infringement; Deposed 12/14/16, 5/25/17; Testified in Court 9/7/17; Retained 8/16 to 9/17.

Orbcomm, Inc. v. CalAmp Corp.

Retained by Sidley Austin on behalf of defendant CalAmp. Case before the Eastern District of Virginia, Case No. 3:16-cv-208 involving U.S. Patent Nos. 6,292,724, 6,611,686, 6,651,001, 6,735,150, and 8,855,626. Expert Declaration on Claim Construction, Reports on Invalidity and Non-Infringement; Retained 5/16 to 2/17.

Navico Inc. and Navico Holdings AS, v. Garmin International, Inc. and Garmin USA, Inc.

Retained by Paul Weiss on behalf of defendant Garmin. Case before the Northern District of Oklahoma, Case No. 14-cv-303 involving U.S. Patent Nos. 8,300,499, 8,305,840, and 8,605,550. Deposed 11/8/15; Retained 10/15 to 10/17.

Johnson Outdoors Inc. and Johnson Outdoors Marine Electronics, Inc., v. Garmin International, Inc. and Garmin USA.

Retained by Paul Weiss on behalf of defendant Garmin. Case before the Middle District of Alabama, Case No. 14-cv-683 involving U.S. Patent Nos. 7,652,952, 7,710,825, and 7,755,974. Retained 10/15 to 5/16. Case dismissed.

Google, Inc. v. Silver State Intellectual Technologies, Inc.

Retained by Paul Hastings on behalf of petitioner Google, Inc. to provide declarations for multiple petitions for *inter partes* review. See IPR2015-01737 and IPR2015-01738. Retained 10/15 to 12/15.

Vehicle IP LLC v. AT&T Mobility, LLC, et al.

Retained by Akin Gump and by Perkins-Coie on behalf of defendants AT&T Mobility LLC; Cellco Partnership; Networks In Motion, Inc.; TeleCommunications Systems, Inc.; and Telenav Inc. Case before the District of Delaware, Case No. 1:09-cv-01007-LPS involving U.S. Patent

No. 5,987,377. Expert Report on Invalidity; Deposed 5/20/16; Retained 9/15 to 1/17. Matter settled.

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. Expert Report on Invalidity; Deposed 10/04/16; Retained 7/15 to 12/16. Matter settled.

Google, Inc. v. Porto Technology Co., Ltd.

Retained by Fish and Richardson on behalf of petitioner Google, Inc., patent owner Porto Technology Inc. IPR2016-00022 and IPR2016-00045. Expert Declarations; Deposed: 7/14/16 (IPR2016-00022); 7/14/16 (IPR2016-00045). Retained 7/15 to 7/20.

Bradium Technologies LLC v. Microsoft Corporation,

Retained by Perkins Coie on behalf of defendant Microsoft Corporation. Case before the District of Delaware (15-0031-RGA). See also IPR2015-01432, IPR2015-01434, IPR2015-01435, IPR2016-00448 and IPR2016-00449. Expert Declarations; Deposed 8/5/16, 02/21/17; (IPR2015-01432); Retained 3/15 to 10/17.

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). Expert Report on Invalidity; Retained 2/15 to 2/21.

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. Submitted Declaration. 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 9/14.

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). Expert Report on Non-Infringement; 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). See also IPR2015-00697, IPR2015-00698, and IPR2015-00700. Deposed: 10/21/16 and 10/22/16 relative to 1:14-cv-00130; 2/5/16 relative to IPR2015-00697; 2/5/16 relative to IPR2015-0068; 2/5/16 relative to IPR2015-0700. IPR Declarations, Expert Report on Validity; Deposed 02/05/16; Retained 5/14 to 7/16.

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). Expert Report on Invalidity; 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). Declaration ISO Claim Construction and Summary Judgement of Invalidity; Expert Report on Invalidity; 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). Expert Report on Invalidity, Expert Report on Non-Infringement; 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). Expert Report on Invalidity, Expert Report on Non-Infringement; Deposed 7/15/13 and 9/20/13; Testified in Court: 9/27/13 and 9/30/13; Retained 4/13 to 9/13.

Commonwealth Scientific and Industrial Research Organisation v. Realtek Semiconductor Corporation

Retained by Sidley Austin, LLP as an expert on behalf of defendant Realtek Semiconductor Corporation. Patent-in-suit is U.S. Patent 5,487,069. Case before the United States District Court for the Eastern District of Texas (Tyler Division) (Case No. 6:12-cv-00578). Expert Report on Invalidity, Expert Report on Non-Infringement; Deposed 3/6/15; Retained 4/13 to 4/15. Matter settled.

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 9/14.

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 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 of 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.

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 3/16.

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 10/17.

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 7/12.

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 (8/27/10) 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, PLLC 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, PLLC 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, PLLC 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.

ECE2019 Sensors, Circuits, and Systems.

This course investigates commonly used sensors such as resistive temperature sensors, capacitive touch sensors, and inductive motion sensors and actuators. Numerous applications are presented to motivate coverage of fundamental operating principles of circuit elements such as resistors, capacitors, and inductors; model the signals produced by these sensors; and analyze the circuits and systems used to amplify and process these signals. After a review of Kirchhoff's current and voltage laws, fundamental analysis techniques such as Thevenin and Norton's theorems and the superposition principle are used to model and analyze sensors, circuits, and systems. Concepts from analysis of linear, time-invariant continuous-time signals and systems are introduced as necessary, including Fourier series and characterization of systems such as filters in both the frequency domain (bandwidth, transfer function) and time domain (rise time, step response). Capacitance, inductance and mutual inductance are explored as energy storage elements, including consideration of resonance and energy losses in power systems. Concepts will be reinforced with the use of laboratory exercises and computer simulation. Recommended background: ECE 2010, MA 1024 (or equivalent), PH 1120/21 and MA 2051 (concurrent) Note: Students who have received credit for ECE 2111 may not receive credit for ECE 2019.

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.

RBE502 Robot Control

This course reviews the interplay between control and robotics through introducing theory and demonstrating applications. It aims to provide an in-depth coverage of control design for robotic manipulators and mobile robots. We focus primarily on fundamental theory, control design methods, and their application on practical robotic systems. Topics may include modeling of robotic systems, linear/nonlinear control of robotic systems, control of under-actuated robotic systems, optimal control, adaptive control, behavior-based robots. Course projects will emphasize modeling, simulation and practical implementation of control systems for robot applications.

RBE594 Capstone Project Experience In Robotics Engineering

This project-based course integrates robotics engineering theory and practice, and provides the opportunity to apply the skills and knowledge acquired in the Robotics Engineering curriculum. The project is normally conducted in teams of two to four students. Students are encouraged to select projects with practical significance to their current and future professional responsibilities. The projects are administered, advised, and evaluated by WPI faculty as part of the learning experience, but students are also encouraged to seek mentorship from experienced colleagues in the Robotics Engineering profession.

3. List of Publications:

3.1 Journal Papers

- [1] DiLuoffo, Vincenzo, and William R. Michalson. "A Survey on Trust Metrics for Autonomous Robotic Systems." arXiv preprint arXiv:2106.15015 (2021).
- [2] V. Diluoffo, W. R. Michalson and B. Sunar, "Robot Operating System 2: The need for a holistic security approach to robotic architectures," *International Journal of Advanced Robotic Systems*, 15.3, 2018.
- [3] 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.
- [4] W. R. Michalson, A. Navalekar and H. Parikh, "Error mechanisms in indoor positioning systems without support from GNSS," *The Journal of Navigation*, Cambridge University Press, vol. 62, no. 2, pp. 239-49, 2009.
- [5] H.K. Parikh and W. R. Michalson, "Impulse Radio - UWB or Multicarrier UWB for Non-GPS based Indoor Precise Positioning Systems," *NAVIGATION J. Inst. Nav.*, Vol. 55, no. 1, 2008.

- [6] 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.
- [7] 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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- [10] G. Bogdanov, W. R. Michalson, and R. Ludwig, "A new apparatus for non-destructive evaluation of green-state powder metal compacts using the electrical resistivity method," *Measurement Science and Technology*, IOP Publishing, vol. 11, pp. 157-166, January 2000.
- [11] B. Findlen, E. Reuter, R. Campbell, and W. R. Michalson, "Effects of time domain response on the sonic characteristics of microphones," *Journal of the Acoustical Society of America*, vol. 104, no. 3, pt. 2 pp. 1764, September 1998.
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- [13] J. Stander, J Plunkett, W. Michalson, J. McNeill, and R. Ludwig, "A Novel Multi-Probe Resistivity Approach to Inspect Green-State Powdered Metallurgy Compacts," *Journal of Non-Destructive Evaluation*, vol. 16, no. 4, pp. 205-214, 1997.
- [14] Woltereck, R. Ludwig, and W. Michalson, "A Quantitative Analysis of the Separation of Aluminum Cans Out of a Waste Stream Based on Eddy Current Induced Levitation," *IEEE Transactions on Magnetics*, vol. 33, no. 1, pp. 772-781, January 1997.
- [15] 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.
- [16] 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.
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- [18] 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] E. Skorina, R. Rameshwar, S. Pirasmepulkul, T. Khuu, A. Caracappa, P. Luxsuwong, M. Luo, W. R. Michalson, and C. Onal, "Soft Robotic Glove System for Wearable Haptic Teleoperation," WM Symposium 2018, March 18 - 22, 2018 - Phoenix Convention Center.
- [2] 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.
- [3] 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.
- [4] 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.
- [5] 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.
- [6] 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.
- [7] J.M. Barrett, M.G. Gennert, W. R. Michalson and J.L. Center, "Analyzing and Modeling an IMU for Use in a Low-Cost Combined Vision and Inertial Navigation System," 2012 International Conference on Technologies for Practical Robotic Applications, Boston, MA Apr. 23-24, 2012.
- [8] G. Fischer, W. R. Michalson, T. Padir and G. Pollice, "Development of a Laboratory Kit for Robotics Engineering Education" AAAI 2010 Spring Symposium on Educational Robotics and Beyond: Design and Evaluation, Mar. 22-24, Palo Alto, CA, 2010.
- [9] W.R. Michalson, and F. J. Looft, "Designing Robotic Systems: Preparation for an Interdisciplinary Capstone Experience," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [10] 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.
- [11] M. Gennert, M. Demietrio and W. R. Michalson, "A Robotics Engineering M.S. Degree," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [12] R. Beach, W. R. Michalson, et. al., "Robotics Innovations Competition and Conference (RICC): Building Community Between Academia and Industry Through a University-

- Level Student Competition,” American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [13] 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.
 - [14] 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.
 - [15] 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.
 - [16] W. R. Michalson, et. al., “Unified Robotics: Balancing Breadth and Depth in Engineering Education”, American Society of Engineering Educators 2009 Annual Conference, AC 2009-1681, Austin, TX, Jun 14-17, 2009.
 - [17] G. Tryggvason, W.R. Michalson, et. al., “Robotics Engineering: A New Discipline for a New Century”, American Society of Engineering Educators 2009 Annual Conference, AC 2009-997, Austin, TX, Jun 14-17, 2009.
 - [18] M. DiBlasi, W. R. Michalson, et. al., “Social Networking in the FIRST Robotics Competition Community,” ASEE Northeast Section Conference, University of Bridgeport, Apr 3-4, Bridgeport, CT, 2009.
 - [19] A. Navalekar, H.K Parikh and William R. Michalson, "Error Mechanisms in Indoor Positioning Systems without Support from GNSS", RIN NAV 08.
 - [20] A. Navelekar, W.R. Michalson, et. al., “Effects of Push-To-Talk (PTT) delays on Throughput Performance of CSMA/CA based Distributed Digital Radios (DDR) for Land Mobile Radio (LMR) Networks,” 37th International Conference on Parallel Processing (ICPP-08), Portland, OR, Sep. 8-12, 2008.
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 - [22] A.C.Navalekar, W.R. Michalson, “A New Approach to Improve BER Performance of a High Peak-to-Average Ratio (PAR) OFDM signal over FM based Land Mobile Radios (LMR)”, IEEE WTS 08, Pomona, CA.
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- [29] C.W. Kelley, W. R. Michalson, et. al., "Discrete vs. Continuous Carrier Tracking Loop Theory, Implementation, and Testing with Large BnT," *Proc. Institute of Navigation GNSS 2007*, Fort Worth, TX, September 25-28, 2007.
- [30] W. R. Michalson and J. W. Matthews, "Distributed Digital Radios and WLAN Interoperability," 2007 IEEE Conference on Technologies for Homeland Security, May 16-17, Woburn, MA, 2007.
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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

Haptic glove as a wearable force feedback user interface

United States Patent 10,551,923, Issued February 4, 2020

A toroidal actuator is responsive to a teleoperator for providing haptic feedback responsive to a curvature or articulated movement applied to a gripped object. The toroidal actuator surrounds an operator member such as a finger, and is responsive to pneumatic pressure for increasing telepresence force defined by resistance encounter against a teleoperated robotic claw. As the teleoperated claw grips an object, increased pneumatic pressure in the toroidal actuator tends to elongate the toroidal shape in a linear manner and oppose a curvature force applied by an inserted operator finger. Resistive force is based on soft sensing of the gripped object, thus the toroidal actuator applies an increasing resistive force to curvature as the robotic claw closes around a gripped object by solenoid regulated air pressure.

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.

Tracking device and remote monitoring system

United States Patent Application US20140274115A1

A system includes a remote monitoring device configured to detect and measure one or more signals and to convey detected and measured signal information to a central location. The central location is configured to determine the location of the remote monitoring device based on the received signal information and is also configured to determine at least one hypothetical path of the remote monitoring device. Abandoned.

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 7,896,807, 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 7,292,189. 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 7,158,643. 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 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 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)

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- [2] *SailBot 2021*, C.J. Burri, M.J. Laks, L.C. Zebrowski, N.H. Jackson, C.J. Scholler, N.J. Eusman, A.V. Thammana, MQP-WZM-SB21, 2021.
- [3] *Ship Recycling Robot*, N.M. Kalsih, S.I. Morales, J. Cybul, J.D. Hoy, T.H. Reiser, MQP-BC2-SRR1, 2021.
- [4] *Tethered Submersible Surveyor*, B.L. Ward, L.C. Reid, J.A. Conklin, J.Y. Huang, MQP-YGB-SUB2/MQP-WZM-SUB1, 2021.
- [5] *Underwater Communications*, L. Spalding, MQP-WZM, 2021.
- [6] *Lionfish III*, MQP-CBP, 2021.

4.2 Major Qualifying Projects (completed)

- [7] **Remote Water Monitoring*, Daniel Shrives, T. Vose, and B. Rolfes, MQP-WZM-AB0R, 2020. [* Winner – Provost’s MQP Award in Robotics Engineering]
- [8] *SailBot 2019-2020 MQP*, I. Lavryonova, T. Andrews, M. Guzman, and K. Reese, MQP-WZM-ABWT, 2020.
- [9] *Firefighting Remote Exploration Device II*, J. Cheng, D. Karavoussianis, A. Moseley, and L. Sahyun, CP4-MQP-FIRE, co-advised, 2020.
- [10] *Mohamed Bin Zayed International Robotics Challenge at Takemura Lab, Osaka University*, N. Greig and D. McHorney, WZM-MQP-ABVE, 2020
- [11] *Lionfish Harvesting Robot – Phase III*, M. Abadjiev, Q. Chen, C. Ewen, N. Johnson, N. Olgado, H. Saperstein, O. Strickland, and C. Whimpenny, WZM-MQP-ABVF, 2020.
- [12] *Underwater 3D Data Collection*, D. Pelaez, T. LaCroce, and N. Budris, WZM-MQP-ABVK, 2020.
- [13] *Efficient Multi Robot Mapping: Quick and Sustained Environmental Surveying with Limited Communication*, D. Abraham, T. Bergeron, and C. Dembski, WZM-MQP-AB0P
- [14] *Leveraging NVMe Management Interface to Provide SES Support for Enterprise Server Diagnostics*. T. P. Mackintosh, WZM-MQP-ABQ3, 2019.
- [15] *Sailbot 2018-19*. S. T. Palmer, K.B. Randall and S. A. Fisher, MQP-KZS-SBOT/MQP-WZM-SAIL, 2019.
- [16] *Firefighting Remote Exploration Device*, E. M. Barinelli, J. L. Berman-Jolton, G. K. MacNeal, K. R. Naras, M. Tasellari, and Y. A. Verdeja. MQP-CP4-ABQE, 2019.
- [17] *Vertical Take-Off and Landing Autonomous Aircraft Design*, Q. C. Barker, T. P. Bergeron, J. A. Goldsberry, J. Romelle, B. H. Pasculano, B. M. Waterman, T. M. Weiss, and Z. J. Zolotarevsky, MQP-RVC-1901, 2019.
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- [21] *Wolfgang: An Autonomous Mobile Robot for Outdoor Navigation*, A. U. Cookson, M.E. Landergan, and S. T. O’Neil, MQP-XIH-AD19, 2019.
- [22] *MGH Biomedical Imaging Tools*, I. Alexiou, MQP-SNM-SNMA, 2019. *Automated Sandwich Assembly*, Derek W. Feehrer, Carter C. Reynolds, Jaime R. Stephen, Taylor A. Stephen, MQP WZM 17A1, 2018.
- [23] *Localization for FRC*, Hu, J., Mitrano, P., Puczydowski, K. and Vere, N., 2017.
- [24] **Sailbot 2017-2018 Final Report*, Burklund, J., Johnson, H., Norris, T. and Shanahan, L. 2018. [* Winner – Provost’s MQP Award in Robotics Engineering, Winner – Professional Writing Award].

- [25] *QRP – Quadrupedal Robotics Platform*, Armsby, Z., Cole, R., Coll, B., Martin, J., and Nagal, A., 2018.
- [26] *Embedded GPU-Based Image & Signal Processing Prototype*, Baker, L and Song, D. Lincoln Laboratories, 2018.
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- [29] *Low Cost Quadrupeds*, Joshua Graff, Kevin Maynard, and Alonzo Martinz, MQP-WZM-16A2, 2017.
- [30] *Fire Response Drone*, John Lomi, Zachary Hood, Kyle Young, Chase St. Laurent, and William Boyd, MQP-WZM-16A3, 2017.
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- [32] **Sailbot 2016*, Nicholas Gigliotti, James Kuszmaul, Tucker Martin, and Ryan Wall, 2016. [* nominated for the Provost's MQP Award in Computer Science].
- [33] *Autonomous Snowblower*, Nicholas Rowles, Daniel Pongratz, Harrison Vaporciyan, , 2017.
- [34] **Body Armor Impact Map System*, Carolyn S. Keyes, ME; Nicholas B. Potvin, ECE; and Zachary R. Richards, CS, MQP-WZM-15A1, 2016. [* winner of the Mechanical Engineering Department's MQP Award].
- [35] *Highway Safety Merge System*, Dante A. Pace, ECE; and Sunghoon Yoon, CS, MQP-MYE-AAS5, 2016.
- [36] *Highway Safety Merge System*, Christopher M. Ellen, RBE; MQP-MYE-AATK, 2016.
- [37] *Collaborative Robotics Heads-Up Display*, Bove, C.P. and Wald, A., WPI Lincoln Laboratories Project Center, 2016.
- [38] *De-Mining with UAVs*, Gregory G Tighe
- [39] *Arc-Liberation of Intermolecular Bond Energy for Marine Propulsion*, Rohan Jhunjunwala, ME; James Deane Jackman, CS; Tyler Jon Ewing, ME; Christopher Michael Byrne, ECE; Christopher William Egan, ECE, 2015.
- [40] *Glovesense Data Glove*, Nathan William Joseph Wiegman, ECE,; Nathan Harrison Wells, ECE; Russell Hagan Hedlund, ECE,; and Mert Can Erad, ECE, 2015.
- [41] *Mobile Motion Capture*, Robert Patrick Dabrowski, ID; and Matthew Stephen Costi, ID, 2014.
- [42] *Intelligent LED Display*, Harrison Chabot Williams, ECE; Rayce Coleman Stipanovich, ECE; and Alexander Joseph Ryan, ECE, 2014.
- [43] **Design and Optimization of a FSAE Vehicle*, Justin Shane Paprota, ECE; and Camden Ryan Mallette, ECE, 2014. [* winner of the Provost's MQP Award in Mechanical Engineering].

- [44] *Sailboat Stabilization System*, Steven Mize Rutledge, ECE; Pedro John Miguel, ECE; Dominic Student author Gonzalez, ECE; and Michael Eric Brendlinger, RBE, 2014.
- [45] *Real Time Person Tracking and Identification using the Kinect sensor*, Nikolaos Matthiopoulos and Matthew Francis Fitzpatrick, 2013.
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- [47] *Automated Refueling for Hovering Robots*, Raymond P. Short, RBE; Janine S. Pizzimenti, RBE; and Nigel Bowers Cochran, RBE, 2012.
- [48] *Improved Intelligence and Systems Integration for WPI's UGV – Prometheus*, Gregory Duncan McConnell, RBE; Samson Michael King, RBE; Craig Alan DeMello, RBE; Michael A. Rodriguez, RBE; and Eric J. Fitting, ID, 2012.
- [49] *Aeacus – development of a bio-inspired robotic platform for swarm-based multi-object transport over uneven terrain*, N. Anderson, D. Praetorius and C. Roddy, co-advised with S. Nestinger, 2011.
- [50] *Realization of Performance Advancements for WPI's UGV-Prometheus*, M. Akmanalp, R. Doherty, J. Gorges, P. Kalasuskas, E. Peterson and F. Polido, co-advised with T. Padir, S. Nestinger, M. Ciraldi, K. Stafford, 2011.
- [51] *Optimization of an Autonomous Underwater Vehicle*, J. Baker, C. Frumento, J. Grzyb and T. North, co-advised w/I. Hussein, 2011.
- [14] *Intelligent Tactical Vest*, V. Brisian, J. Fernando, A. Khandaker and J. Zorrilla DeLos Santos, 2011.
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- [21] *Autonomous Vehicle Control*, Breznak, R. S., Cunningham, A. G and Kleinfeld, Z., 2008.
- [22] *Roof Robot Phase 2*, Zachary James Strowe, ECE; and Xu Lin, ECE, 2008.
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- [24] *Public Safety Integration Center*, P. Lucia, I. Levin and M. Barone, WZM-1A08, 2008.

- [25] *Aircraft Lasercom Terminal Compact Optical Module*, B. Scoville and S. Rose, Lincoln Laboratory Project Center, WZM-2A08, 2008.
- [26] *PANSAT Triple Modular Redundant (TMR) Satellite Flight Computer v3*, Kevin Zhang, ECE; and Karim G. Makram, ECE, 2006.
- [27] *GPS Attitude Determination System*, J.P. Salmon, Michael LaBossiere and Mark Minotaur, 2005.
- [28] *FPGA Implementation of an OFDM Modem*, Andrew Dupont and Jack Coyne, 2005.
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- [30] *Construction of a GPS Pseudolite*, Tim Coffey, 2005.
- [31] *Dipole Antenna Placement in a Falcon-20 Aircraft*, Emily Anesta and David Plourde, Lincoln Laboratories Project Center, A-Term, 2004.
- [32] *GPS Attitude Determination System*, Joshua Holwell, Himanshu Agrawal and Andrew Coonradt, 2004.
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- [34] *Personal Inertial Navigation System*, Jason DeChiaro and Christopher Strus, 2003.
- [35] *WZM-MQP-4A02: PC I/O in High Stress Environments*, John Niesz and James Kent, 2003.
- [36] *WZM-MQP-2A02: Vacuum Tube Amplifier*, Joseph Kambourakis and Gregory Molnar, 2003.
- [37] *Container Tracking System*, Victoria Chaplick, 2003.
- [38] *WZM-MQP-2A03: Heat Management System for PCs*, Ernest Cardin, Kevin Candiloro and Stephen Leavey, 2002.
- [39] *WZM-MQP-1313: Digital Image Enhancement*, Julie Bolduc, Joeseeph Perry, Wei Fu, 2002.
- [40] *WZM-MQP-2A01: Synchronized Audio Sample Looper*, Joel Gottshalk, Robert Conrad and Sanford Freedman, 2002.
- [41] *WZM-MQP-1A01: Springboard Digital Multimeter*, Pavel Loven and Andrew Young, 2002.
- [42] *Ballistic Missile Defense Analysis Toolkit*, Winfield Peterson, Doug Tilkin and Benjamin Wilson, Lincoln Laboratories Project Center, 2002.
- [43] *HU-FB-CS01, C Sound Synthesizer*, Peter W. DeBonte (co-advised).
- [44] *WZM-MQP-1A00: StrongArm-Based Computer System*, Bradford Snow, 2001.
- [45] *WZM-MQP-1C01: PC Controlled Laser Light Show Device*, Joel Smith, 2001.
- [46] *WZM-MQP-1E00: PIC-based MIDI Sequencer* Malcolm Beaulieu, 2001.
- [47] *WZM-MQP-2A00: Automotive PC Development Platform* Travis Pouliot and David Philips, 2001.

- [48] *The RoadCom Automotive Computing System*, Benjamin Kennedy and John Pong, 2000.
- [49] WZM-MQP-1A99: *Compressed Sample Wavetable Synthesizer*, Justin Brzozoski, 2000.
- [50] WZM-MQP-3499, *Automatically Equalizing Monitor*, Fernando Braghin, Tenzin Lama, Rahul Bhan and Dion Soetadi, 2000.
- [51] 99D163M: *Railroad Communication*, Benjamin Richards, 2000.
- [52] CS-MXC-IE00: *PIC Real-Time Sequencer*, Alexander Goodrich, 2000.
- [53] 99D514M: *Design of a Microphone Preamplifier*, Eric Reuter, 2000.
- [54] WZM-MQP-1A99, *MPEG Audio Deck*, Justin Brzozoski, 2000.
- [55] *Digital Image Enhancement*, Julie Bolduc, Wei Fu and Joseph Perry, 2000.
- [56] WZM-MQP-4A98, *Railroad Communications System*, Matthew Lug, 1999.
- [57] 99D078M: *Modular Effects Processor II*, Erik Neyland, 1999.
- [58] 99D176M: *Portable Digital Audio Recorder* Eric Toledo and Duc Truong, 1999.
- [59] EE-WZM-1A97, *C Sound Synthesizer*, Ross E. Borgeson, Michael W. Hamel and Matthew S. Walsh, 1998.
- [60] EE-WZM-4A97, *Firewire Audio Device*, Daniel R. Stutzbach, 1998.
- [61] EE-WZM-2A97, *Modular Effects Processor*, Michael J. Dellisanti, 1998.
- [62] EE-WZM-3A97, *GPS Personal Navigation*, Jeffery A. Alderson and Helder Machado, 1998.
- [63] HU-FB-CS01, *C Sound Synthesizer*, Peter W. DeBonte (co-advised).
- [64] EE-WZM-1E97, *PM Measurement System*, Yevgeniy Bogdanov.
- [65] EE-REL-C008, *Design and Development of a Microprocessor-Based Gaussmeter*, David M. Burnham.
- [66] EE-WZM-RC01, *Acoustic Guitar Amplifier*, Christopher Thomas.
- [67] EE-WZM-GSD1, *Guitar Sustaining Device*, Paul D'Ambra.
- [68] EE-RXV-5260, *Audio Feedback Elimination System*, Ross D. Pease and John R. Pelliccio.
- [69] EE-RJD-M963, *Embedded Systems Design*, Christopher A. Briggs and Anthony J. Viapiano.
- [70] EE-WHE-9601, *GPS Hazard Detector*, Michael Roberts, William Cidela, and Chris Mangiarelli.
- [71] EE-WZM-2C96, *Flexible Synthesis*, Noah T. Vawter and Luke Demoracski.
- [72] EE-WZM-1A96, *Tap Dancer MIDI Interface*, Thomas Trela and William Dowell.
- [73] EE-WZM-2A96, *GPS Hazard Detector II*, Will Brothers, Jon Day, and John Zaghi.
- [74] EE-WZM-3A96, *Loudspeaker Data Acquisition System*, Adam Gross.
- [75] EE-WZM-4A96, *Audio Morphing Processor*, William Butterfield and Ted Phipps.

- [76] EE-WZM-5A96, *Acoustic Modeling*, Peter DeBonte.
- [77] EE-WZM-1B96, *Distributed Audio Controller*, Stephen S. Richardson.
- [78] EE-WZM-1A95, *Acoustic Hazard Meter*, Ronald D. Slack.
- [79] EE-WZM-2A95, *Forest Service DGPS*, Joshua J. Single and Michael T. Spadazzi.
- [80] EE-WZM-1C95, *Audio to MIDI Converter*, Jennifer R. Principe.
- [81] EE-WZM-1D95, *Low Cost Auralizer*, Jason R. Hills and Mark R. Paulson.
- [82] EE-WZM-3A95, *Passive Radiator Design*, Kevin R. Weldon.
- [83] EE-WZM-1C94, *Char Model Generation*, Colin J. Florendo.
- [84] EE-WZM-1D94, *Wide Area DGPS Simulator*, Daniel Cohen and Robert Schroter.
- [85] EE-WZM-2D94, *Digital Soundcard*, Timothy Alsberg (Russian Project Center).
- [86] EE-WZM-3D94, *Digital Univibe*, Andrew Willis and Daniel Toohey.
- [87] EE-WZM-1A94, *DSP Based Real-Time Audio Feedback Eliminator*, Kevin M. Eddy.
- [88] EE-WZM-2A94, *Digital LCD Oscilloscope*, William F. Brown and John F. Ebersole.
- [89] 93D236M, *MIDI Mapper*, Jonathan Kemble and Brian Candiloro.
- [90] EE-WZM-1C93, *Fault-Tolerant Computer*, Frederick N. Parmenter.
- [91] EE-WZM-1A93, *Wireless MIDI Controller*, Sanjay Raja, Charles Cimalore, Ty Panagoplos.
- [92] EE-WZM-2A93, *Multiple Pitch Detector*, Jeanne A. Sawtelle.
- [93] EE-WZM-3A93, *Multiprocessor Cache Coherence*, Lauren C. Lind and Norman E. Rhodes.
- [94] EE-WZM-1C92, *A Simulation of the DLX Architecture*, Lisa Harlow.
- [95] EE-WZM-2C92, *A New Microprocessor Development System*, Gregory B. Burlingame, David J. Fortin, Kevin S. Pearson.
- [96] EE-WZM-1A92, *Digital Audio Sampler*, Roger D. Gagnon and James M. Lach.
- [97] EE-WZM-2A92, *Intelligent Harmonizer*, Prabhjot S. Anand and Aftab M. Yusuf.
- [98] EE-WZM-3A92, *Computerized Audio Mixer*, Richard J. Wood.
- [99] EE-WZM-1B92, *Real-Time Harmonizer*, Mohiuddin M. Kahn.
- [100] EE-WZM-1A91, *Residue Number System Processor*, Ravdeep S. Anand and Christine A. Easton.
- [101] EE-WZM-2A91, *SCSI Bus Analyzer*, Brian Costello, George Delouriero, Matthew Maguire, and Keith Nevins.

4.3 Interactive Qualifying Projects (completed)

- [1] *Bell Towers*, Bowman, I.H., Casciola, I.O., Adiletta, M.J., Bruneau, C.D., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [2] *Creating a Circular Economy with Urban Farming*, Ward, B.L., Cyran, B., Premo, J., Soens, N., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [3] *Plastic-Free Venice*, S.L. Bonanno, V.C.Nguyen, A.H. Hagedorn, T.S. Howlett, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [4] *30th Anniversary Exhibit*, N. Bajakian, J. Wong, J. DeDonato, and N. Stallings, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [5] *Venice Crowdfunding*, T. Ferrara, F de Leo, M. Bernardo and S. O'Connell, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [6] *Visitor Experiences in Venice*, T. King, C. Anderson, M. Laks, and C. Hoey, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [7] *Venice From Above: Preserving Venetian Bell Towers*, Iuliano, C.T., Kavassalis, F.I., Colucci, N.D., Lessard, P., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [8] *Celebrating 30 Years of the Venice Project Center*, Ellis, E.J., Morton, K.J., Carpinì, N.A.D., Hale, S.A., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [9] *PreserVenice Launch: A Crowdfunding Solution to Preserving Venetian Heritage*, Hetherington, B.F., Berardi, D., Thompson, K.R., Joy, S.P., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [10] *Tech Mecca in Giudecca*, McMahon, A.J., Hiscox, C.A., Maida, P.J., Lee, R.T., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [11] *Exploring Urban Permaculture: Initializing a Path to a Greener Venice*, Jordan, A.S., O'Driscoll, K.J., Manca, R. A., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [12] *Open For Business: Analyzing Venetian Storefronts*, Bartone, J.R., Scales, K.J., Racca, S.R., Chen, Y., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [13] *Venice Without Obstacles*, DeRusha, A.C., Abenante, E.R., DiStefano, M.S., Jones, S.A., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [14] *Documenting and Promoting the Impacts of the Melbourne Project Center*, Seely, C.A., Day, J.L., Cochran, I.L., and Carlson, K.A.M., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [15] *Students' Mental Wellbeing in Universities Located in Melbourne*, Isaro, A., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [16] *I See a Psychologist -- Reducing Stigma through Normalizing Mental Health Care in Australia*, Vayas, NN., Daci, E.G., and Bianco, C.E., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.

- [17] *Improving Web Presence and Stakeholder Interaction for the Emergency Services Foundation*, Savage, H.A, Sanchy, M.T., Capozzi, R. and Babel, B.M., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [18] *Understanding Visitor Experiences at the Pauline Gandel Children's Gallery*, Nigro, J.T., France, G.T., Coppolino, J.R. and Blakslee, B.S., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [19] *A Citizen Science Platform for Long-Term Monitoring of Microplastic Pollution in Port Phillip Bay*, Bayas, A.C., Buckley, M.J., Ford, C.K. and Lawes, J.A., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [20] *A Comprehensive Methodology for Assessing the Quality of Solar Photovoltaic Systems*, Arthur, D.P., Hoey, C.J., Laffer, T. and Westgate, B., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [21] *High Efficiency Power Inverter*, Grzegorz J. Klos and Robert Hall, 2015.
- [22] *An Analysis and comparison of affordable and ecological short-term transportation energy solutions*, Bryan Thomas Gleason, 2009.
- [23] *Lens and Lights Operational Overview*, Andrew Thomas Wilkins, ECE; Matthew Houstle, ECE; and Anthony R. Azersky, CS, 2009.

4.4 Graduate Theses Advised and Co-Advised

4.4.1 MS Theses (current)

- [1] Pratik Jawahar, “High-Level Exogenous Fault Detection in Multi Robot Systems with Variational Autoencoders and Normalizing Flows,” MS Thesis, co-advisor, 2022.
- [2] Rohan Walia, “Formation-Centric Software Interface,” MS Thesis, co-advisor, 2022.

4.4.2 MS Theses (completed)

- [1] Nathaniel Michaels, “A Modular Robotic AFO for detecting phase changes during Walking Gait,” MS Thesis, co-advisor, 2020.
- [2] Hernandez, A. C., “Implementing and Comparing Image Convolution Methods on an FPGA at the Register-Transfer Level,” MS Thesis, co-advisor, 2019.
- [3] Katie Gandomi, “Implementation of a Modular Software Architecture on a Real-Time Operating System for Generic Control over MRI Compatible Surgical Robots,” MS Thesis, co-advisor, 2018.
- [4] Adhavan Jayabalan, “Decentralized Persistent Connectivity Deployment in Robot Swarm,” MS Thesis, co-advisor, 2018.
- [5] Janani Mohan, “Dynamic Task Allocation in Robot Swarms with Limited Buffer and Energy Constraints,” MS Thesis, co-advisor, 2018.
- [6] Rogers, J.P., GNSS and Inertial Fused Navigation Filter Simulation, MS Thesis, co-advisor, 2018.

- [7] Christopher Bove, "Constrained Motion Planning System for MRI-Guided, Needle-Based, Robotic Interventions," MS Thesis, co-advisor, 2018.
- [8] Vyas, Shivang, "Feature detection in an indoor environment using Hardware Accelerators for time-efficient Monocular SLAM," MS Thesis, primary advisor, Worcester Polytechnic Institute, 2015.
- [9] Morin, Russell, "A Novel Localization System For Experimental Autonomous Underwater Vehicles," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2010.
- [10] Navalekar, Abhijit, "Design of an OFDM-Based VHF Modem," MS Thesis, primary advisor, Worcester Polytechnic Institute.
- [11] Ahlehagh, Hasti, "Techniques for Communications and Geolocation Using Wireless Ad Hoc Networks," MS Thesis, primary advisor, Worcester Polytechnic Institute, 2004.
- [12] Sebastian, Dalys, "Development of a Field-Deployable Ultrasound Scanner System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2004.
- [13] Tobgay, Sonam, "Novel Concepts for RF Surface Coils with Integrated Receivers," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2004.
- [14] Breen, Daniel, "Characterization of Multi-Carrier Locator Performance," MS Thesis, co-advisor, 2004.
- [15] 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.
- [16] Fei, Ming, "Electromagnetic Detection, Infrared Visualization and Image Processing Techniques for Non-Metallic Inclusions in Molten Aluminum," MS Thesis, co-advisor, 2002.
- [17] Lavoie, Bruce, "Design and Implementation of an N-Channel Self Calibrating Audio System," MS Thesis, primary advisor, Worcester Polytechnic Institute, 2000.
- [18] Bogdonov, Gene, "Theoretical and Practical Implementation of Electrical Impedance Material Inspection of Powder Metallurgy Compacts," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1999.
- [19] Messier, Andrew, "Modeling the Effects of Terrain Masking on GPS Accuracy and Integrity," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1998.
- [20] Antonescu, Bogdan, "Elliptic Curve Cryptosystems on Embedded Microprocessors," Bogdan Antonescu, MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.
- [21] Lai, Qiang, "Ground-Penetrating Radar Data Processing System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.
- [22] Soria-Rodríguez, Pedro, "Multicast-Based Interactive-Group Object-Replication For Fault Tolerance," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.
- [23] Hoy, William, "Audio Signal Denoising Using Wavelets," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1997.

- [24] Proгри, Ilir, "Harmonic Flow Monitoring by means of Global Positioning System," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1997.
- [25] Bretchko, Pavel, "Pulsed Hysteresis Graph System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1997.
- [26] Repkin, Dmitry V., "A Hierarchical Neural Network Based Data Processing System for Ground Penetrating Radar," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1997.
- [27] Metsis, Sophocles, "Design of a Real-Time Capable, Fault-Tolerant, Distributed System," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1996.
- [28] Hill, Jonathan, "Efficient Implementation of Mesh Generation and FDTD Simulation of Electromagnetic Fields," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1996.
- [29] Dunkelberg, John, "FEM Mesh Mapping to a SIMD Machine Using Genetic Algorithms," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1996.
- [30] Leuenberger, Georg, "Design and Development of a Microprocessor Based Gauss Meter," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1995.
- [31] Valentino, Ralph, "DISC: A Dynamic Instruction Set Coprocessor," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1995.
- [32] Muley, Aalok, "A Fault Tolerant Network for a Real-Time Environment," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1994.
- [33] Mohan, Surrender, "Automatic Surface Mesh Generation for 3D Solid Models Using Delaunay Algorithm," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1994.
- [34] Petrangelo, John, "Experimental Preconditioners for Large Dense Systems," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1994.
- [35] Schneider, Eric, "Design, Simulation, and Analysis of a 3D Integrated Optical Computer," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1993.
- [36] Palmer, Bradley, "A Comparison of Three Protocols Supporting Time-Dependent and Time-Independent Communications," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.
- [37] Clayton, Shawn, "An Analysis of the Real-Time Behavior of Galactica Net," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.
- [38] Levergood, Thomas, "An Experimental Evaluation of Split User/Supervisor Cache Memories," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.
- [39] Lavalee, James, "The Design and Development of Real-Time Systems Using Ada and the Activation Framework," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1992.
- [40] Velazques, Javier, "The Development of a Real-Time Environment Using the Activation Framework," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1992.

4.4.3 Ph. D. Dissertations (current)

- [1] Vincenzo Diluoffo, “Security in the Robot Operating System Version 2 (ROS 2) Environment,” primary advisor.
- [2] Jitesh, “Ad-Hoc Networking for Bandwidth Limited LMR Systems,” primary advisor.

4.4.4 Ph. D. Dissertations (completed)

- [1] Carvalho, P. A., “Advancing Technologies for Interventional MRI Robotics with Clinical Applications,” 2019.
- [2] Ferreira, PVR “SRML: Space Radio Machine Learning,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2017.
- [3] Iyer, Vishwanath, “Broadband Impedance Matching of Antenna Radiators,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2010.
- [4] Navalekar, Abhijit, “Distributed Digital Radios For Land Mobile Radio Applications,” Ph.D. Dissertation, primary advisor, Worcester Polytechnic Institute, 2009.
- [5] Parikh, Hemish, “Design of an OFDM Transmitter and Receiver for Precision Personnel Location,” primary advisor.
- [6] Proгри, Ilir, “An Assessment of Indoor Geolocation Systems,” Ph.D. Dissertation, primary advisor, Worcester Polytechnic Institute, 2003.
- [7] Li, Xinrong, “Super-Resolution TOA Estimation with Diversity Techniques for Indoor Applications,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2003.
- [8] Leuenberger, Gerog H. W., “Electrostatic Density Measurements in Green-State PM Parts,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2003.
- [9] Bogdanov, Gene, “Radio-Frequency Coil Design for High Field Magnetic Resonance Imaging,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2002.
- [10] Elbirt, Adam J., “Reconfigurable Computing for Symmetric-Key Algorithms,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2002.
- [11] Bretchko, Pavel, “Design and Development of Ultra-wideband DC-Coupled Amplifier,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2001.
- [12] Hill, Jonathan, “Development of an Experimental Global Positioning System (GPS) Receiver Platform for Navigation Algorithm Evaluation,” Ph.D. Dissertation, primary advisor, 2001.
- [13] Spasojević, Mirko, “Creation of Sparse Boundary Element Matricies for 2-D and Axis-symmetric Electrostatic Problems Using a Bi-orthogonal Wavelet,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 1997.
- [14] 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:

5.1 Funding Received

\$300,000	MRI: Development of an autonomous, Connected and Data-Driven Vehicle for Multi-Disciplinary Research, Co-PI, 09/13/16.
\$200,000	Advanced Bayesian Methods for Autonomous Navigation, Co-PI, 07/25/11.
\$50,524	PCOG Broadband Modem, PI, \$50,524, 05/15/09.
\$839,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 09/06/07.
\$83,726	State Communications Interoperability, PI, 07/18/07.
\$224,822	MANET Protocols for Capacity-Limited Channels, PI, 03/08/07.
\$44,366	TATRC: Wireless Sensor Communications, Co-PI, 12/20/06.
\$95,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 02/13/06.
\$3,225,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 12/19/05.
\$1,973,286	Precision Indoor/Outdoor Personnel Locator, Co-PI, 09/23/05.
\$25,000	Sensor-on-a-Chip for Electrophysiological Monitoring, Co-PI, 08/08/05.
\$1,245,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 12/23/04.
\$1,370	WPI-NanoSAT Program, Co-PI, 11/03/04.
\$37,408	Precision Indoor/Outdoor Personnel Locator, Co-PI, 10/05/04.
\$74,048	Real-Time Troop Physiological Status Monitoring System, PI, 09/15/04.
\$813,141	Real-Time Troop Physiological Status Monitoring System, PI, 12/08/03.
\$255,496	Precision Indoor/Outdoor Personnel Locator, Co-PI, 10/31/03.
\$3,246	WPI-NanoSAT Program, Co-PI, 10/20/03.
\$2,789	WPI-NanoSAT Program, Co-PI, 03/06/03.
\$827,000	Real-Time Troop Physiological Status Monitoring System, PI, 11/22/02.
\$14,866	Norfolk County Sheriff's Office Data Mining, Co-PI, 02/01/02.
\$54,483	Auto-calibrating surround sound system, PI, 2001.
\$11,252	Auto-calibrating surround sound system, PI, 2000.
\$18,977	GPS-Based Attitude Determination System, PI, 07/1998.
\$70,000	Development of an Electric Resistivity Instrument for the Testing of Green-State P/M Compacts, Co-PI, 01/1997.
\$10,550	GPS Hazard Detection, Co-PI, 1996.
\$200,000	Integrity for the Global Positioning System - Supplemental Funding I, Co-PI, 1995.
\$3,000	GPS-Based Tracking of Forest Vehicles, PI, 1995.

\$7,200	Acoustic Identification of Mosquito Species, Co-PI, 1995.
\$9,978	Acoustic Identification of Mosquito Species, Co-PI, 1995.
\$11,527	Laboratory Equipment for Microkernel Based Embedded Systems, Co-PI, 1995.
\$74,388	RF Circuit and Antenna Modeling on High Performance Computers, Co- PI, 1994.
\$199,075	Integrity for the Global Positioning system, PI, 1994.
\$326,336	3D Modeling of Microwave Antennas on High-Performance Parallel Computers, Co-PI, 1993.
\$338, 687	Integrity for the Global Positioning system, Co-PI, 1993.

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
- National Academy of Inventors
- Society of Automotive Engineers

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