UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT TRIAL AND APPEAL BOARD

WESTINGHOUSE AIR BRAKE TECHNOLOGIES CORPORATION
Petitioner

v.

SIEMENS INDUSTRY, INC.
Patent Owner

CASE: IPR2017-01263
U.S. PATENT NO. 6,996,461

DECLARATION OF STEVEN R. DITMEYER

I, Steven R. Ditmeyer, do hereby declare and say:

1. I am over the age of twenty-one (21) and competent to make this declaration. I am also qualified to give testimony under oath. The facts and opinions listed below are within my personal knowledge.

2. I am being compensated for my time in this proceeding at my standard consulting rate of $250/hr. My compensation in no way depends on the outcome of this proceeding or the content of my opinions. I am not employed by, nor receiving grant support from, the Petitioner in this matter. I am receiving compensation from Petitioner solely for my involvement in this matter and based only on my standard hourly consulting fees.

3. I have been asked to review certain documents, including U.S. Patent No. 6,996,461 (which I refer to as the '461 Patent) (Ex. 1001) and to provide my opinions on how those of skill in the art (as defined herein) would understand those documents. The documents I was asked to review include those addressed in more detail in the rest of this declaration. I provide my conclusions regarding the disclosures of these documents below.

4. Of particular relevance to the '461 Patent, I have reviewed and am familiar with the following documents:

   a. U.S. Patent No. 5,092,544 to Petit et al. ("*Petit*") (Ex. 1008);

b. PCT Publication No. 02/091013 to Blesener et al. ("*Blesener*") (Ex. 1007);

c. A document titled "Railroad Safety Advisory Committee, Report" dated August, 1999 ("*RSAC*") (Ex. 1005 and Ex. 1017); and

d. Federal Railroad Administration, Report to Congress (July 1994) ("FRA Report") (Ex. 1009).

5. I have also participated in additional searches for materials related to Positive Train Control ("PTC") and grade crossing systems from before the filing of the '461 Patent, and provided counsel with several dozen articles, brochures, videos, and textbooks from my own files. I identified some of these materials from a review of files related to my employment at Burlington Northern Railroad and at the Federal Railroad Administration ("FRA").

6. I was asked to provide my opinion on the technical feasibility of combining certain aspects of certain documents. I have offered my opinion on the feasibility of such combinations in this declaration.

7. I am not offering any conclusions as to the ultimate determinations I understand the Board will make in this proceeding. I am simply providing my opinion on the technical aspects of the documents (including, where asked, the application of what I understand Petitioner asserts is the

appropriate construction for this proceeding) and on the motivations and combinability of the concepts disclosed in those documents from a technical perspective.

BACKGROUND

8. I received a Bachelor of Science degree in Industrial Management from the Massachusetts Institute of Technology ("MIT") in 1963. While at MIT, I was elected to the Tau Beta Pi engineering honorary society and was a member of the U.S. Army ROTC program, from which I was a Distinguished Military Graduate. For my thesis, I developed the first FORTRAN-based train performance calculator. I subsequently received a Master of Arts degree in Economics and a Certificate in Transportation from Yale University in 1965.

9. At Yale University, I was a Strathcona Fellow in Transportation. As a recipient of the fellowship, I applied the proceeds to my studies in the construction, equipping, and operation of railroads for the efficient transportation of passengers and freight, as well as the financial and regulatory issues involved.

10. My experience in the field of transportation spans both the private and public sectors. In the private sector, I worked for six railroads and a railroad equipment manufacturer. In the public sector, I served as a military officer,

a federal civil servant, and an international civil servant. My career has also cut across multiple disciplines, including freight and passenger transportation, engineering, economics, research and development, policy, marketing, management, operations, information technology, and education.

11. During summers and after college, I learned practical railroading by working for the Terminal Railroad Association of St. Louis, the New York Central Railroad, the Erie-Lackawanna Railroad, and the Missouri Pacific Railroad, spending time and collecting information in control centers, at yard offices, and on trains.

12. I received a reserve commission in the Army Transportation Corps after graduating from MIT. After completing my studies at Yale, I was trained at the U.S. Army Transportation School at Fort Eustis, Virginia, in 1966. I then served on active duty as a 1st Lieutenant and later Captain with the Office of the Special Assistant for Strategic Mobility in the Organization of the Joint Chiefs of Staff from 1966 to 1968. I spent a portion of my time in the National Military Command Center and the Alternate National Military Command Center and worked on analyses of deployment feasibility and on Department of Defense capital investments in transportation aircraft, ships, and facilities. After completing active duty service, I served in the Army Reserve with the 1001st R&D Group, the Military Traffic Management and

Terminal Service, and HQ, 3rd Transportation Brigade (Railways), eventually retiring with the rank of Major.

13. I was hired by the FRA, a unit of the U.S. Department of Transportation ("DOT"), in 1968. I worked there on three separate occasions in the course of my career. I started as an Operations Research Analyst in the Office of High-Speed Ground Transportation, where I managed the preliminary engineering and economic studies for the Northeast Corridor Transportation Project and participated in the creation of Amtrak and of the Transportation Technology Center in Pueblo, Colorado.

14. From 1974 to 1977, I worked at the World Bank, where I served as a transportation economist and supervised infrastructure, train control, and rolling stock rehabilitation projects on railroads in Turkey, Tunisia, Algeria, Spain, and Portugal.

15. I returned to the FRA in 1977, this time as the Associate Administrator for Policy. In this role I oversaw studies on the health of the railroad industry. I conducted hearings around the country regarding recommendations for changes in the regulation of the freight railroad industry and helped develop the legislative package for railroad deregulation, which eventually became the Staggers Rail Act of 1980. In 1979 and 1980 I was detailed by the FRA to the then-Federal-government-owned Alaska Railroad where I served as

Acting General Manager and managed all aspects of the railroad's freight, passenger, intermodal, and river barge operations. I also took steps to initiate the sale of the railroad to the State of Alaska. I then returned to the FRA headquarters as Associate Administrator for Research and Development from 1980 to 1981.

16. From 1981 through 1993, I served as Director of Research and Development for the Burlington Northern ("BN") Railroad. I was also Chief Engineer – Telecommunications and Control Systems from 1986 through 1992. At BN, I oversaw the development of the first communications-based train control system ("CBTC") (later known as a positive train control, or PTC, system), the application of automatic equipment identification RFID tags, locomotive health monitoring, cathode ray tube ("CRT") displays in locomotive cabs, and the first natural gas-fueled locomotives. I also managed BN's telecommunications network, one of the largest non-common carrier systems in the U.S., and oversaw the development of BN's Communications Network Control Center and the deployment of the first digital communications network on a U.S. railroad.

17. Shortly after arriving at BN, I wrote a letter to Rockwell International asking if they would be interested in working with BN to see if their avionics systems could be applied to railroads to improve their safety and efficiency.

They responded that they would be willing to work with BN to learn more about railroad operations and to inform BN about the functioning of avionics systems. After about two years, BN and Rockwell concluded that it would indeed be feasible to apply avionics technologies—in particular, digital communications, global positioning system ("GPS") receivers, sensors, and onboard and control center computers—to railroads. BN and Rockwell began referring to these technologies as the Advanced Railroad Electronics System or ARES. By 1985, I was able to present a plan of action, which was approved by BN's Chairman and Board of Directors, for a demonstration program of these technologies. The demonstration program ran successfully for five years, from 1987 to 1993. A Harvard Business School case study was published about the ARES program in 1991.

18. From 1993 through 1995, I worked at Morrison Knudsen Corporation's Locomotive Division, where I served as Vice President of Marketing and Business Development. There, I marketed new high-horsepower alternative fuel locomotives to railroads along with the company's traditional products, remanufactured freight and commuter locomotives. I also directed the provision of locomotives and maintenance services to several Railroads, including BN. Additionally, I oversaw the assembly of Iron Highway roll-on, roll-off intermodal trainsets for client CSX.

19. In 1995, I returned to the FRA for a third stint, this time as Director of the Office of Research and Development. In this role I directed a program covering a wide range of topics, including system safety and security, human factors, rolling stock and components, track and structures, track-train interaction, train control, grade crossings, hazardous materials, and protection of train occupants. I also served as a member of the DOT Positioning/Navigation Executive Committee, the GPS Senior Steering Group, and as program sponsor for the Nationwide Differential GPS network, a joint project with the U.S. Coast Guard.

20. From 2003 to 2007, I was detailed by the FRA to the Industrial College of the Armed Forces, National Defense University, Fort Lesley J. McNair, Washington, D.C., where I served as U.S. Department of Transportation Faculty Chair, Associate Professor of Economics, and Leader of the Transportation Industry Study. The Transportation Industry Study addressed issues that cut across all modes, such as economics, operations, technology, C^3I (command, control, communications, and information) systems, infrastructure, regulations, leadership, institutions, finance, safety, security, congestion, and intermodalism. In my lectures and papers I made the connection between the Department of Defense's doctrine of Network-

Centric Warfare and the application of network-centric systems to transportation.

21. For these reasons and because of my technical experience and training as outlined in my *curriculum vitae* (Ex. 1003), I believe I am qualified to offer technical opinions regarding the '461 Patent and the other documents I reviewed as part of my work in this matter. I believe I am capable of opining about the start of the art in these areas at various points in time from the early 2000s to the present, as I have been familiar with the academic understanding of the field of train safety communication and commercial work being done by WABTEC and others in the industry in the past 20 years.

OVERVIEW OF POSITIVE TRAIN CONTROL AND GRADE CROSSINGS

Brief History of Positive Train Control

22. Devices to assist with stopping and controlling trains have been in use since the beginning of the twentieth century. Early designs were crude mechanical and electromechanical devices that failed frequently. So-called wayside block signal systems of the era were of varying designs, including mechanical, pneumatic, hydraulic, electromechanical, and electropneumatic systems, and had generally poor reliability. (Ex. 1009 at 11).

23. From the 1970's, through the early 90's, the National Transportation Safety Board issued a series of recommendations to the Federal Railroad Administration ("FRA") relating to safety standards and the development of automatic train control and positive train separation systems. (Ex. 1009 at 39). In 1994, the FRA forwarded a report to Congress, which concluded that PTC systems would increase safety of rail systems and improve train operations in a variety of ways. (*See generally* Ex. 1009). The FRA also established a working group called the Railway Safety Advisory Committee ("RSAC") that defined the three core functions of PTC: (1) prevent train-to-train collisions; (2) enforce speed restrictions, including civil engineering restrictions and temporary slow orders; and (3) provide protection for roadway workers and their equipment operating under specific authorities. (Ex. 1005 at 3; Ex. 1017 at 3).

Technical Evolution

24. Since the early 1980's, the railroad industry has been aware of the potential advantages of using data radio communications, microprocessor-based systems, and other technologies to improve the performance of train control systems. (Ex. 1005 at 1; Ex. 1017 at 1). Advanced train control systems and other PTC systems were first developed in the mid-1980s in response to the enactment of the Staggers Rail Act of 1980. (Ex. 1005 at viii; Ex. 1017 at

vi). The primary goal of these systems was to create a better train control system that would cost less and be more effective than previous systems. By 1999, at least twelve (12) projects were in progress to develop CBTC or PTC systems. (Ex. 1005 at 20; Ex. 1017 at 19).

25. In the early 1980's, the Railway Association of Canada ("RAC") began a project to develop a radio-based train control system with the primary objective of eliminating human error in the train operations. In a joint effort with the Association of American Railroads ("AAR"), RAC issued a report detailing possible operating requirements for an Advanced Train Control System ("ATCS"). ATCS was conceived as a train control system utilizing microprocessors and digital data communications to interconnect elements of the railroad, locomotives, track forces, and wayside devices to the dispatcher's office. (Ex. 1009 at 40).

26. These specifications defined five major systems that comprised ATCS: the Central Dispatch System, the On-Board Locomotive System, the On-Board Work Vehicle System, the Field System, and the Data Communications System. (Ex. 1005 at 22; Ex. 1017 at 21). The On-Board Locomotive system included an onboard computer ("OBC") capable of calculating predicted braking curves on a continuous basis and further included automatic stop protection. (Ex. 1009 at 41). A locomotive display would

show the mileage, speed limits, actual train speed, and track grade. (Ex. 1009 at 43).

27. Between the 1980's and the 1990's, several railroads developed and tested ATCS systems and components of systems as a result of the RAC and AAR's efforts. (Ex. 1009 at 43).

28. In 1985, Burlington Northern (BN) contracted with Rockwell International (now Rockwell Collins) for the development of hardware and software to be installed on BN's trackage serving the Minnesota Iron Range for a demonstration program in revenue service on 230 miles of track, 17 locomotives, and three maintenance vehicles. (See Ex. 1005 at 23; Ex. 1017 at 22). ARES included three major segments: (1) the Control Segment; (2) the Data Segment; and (3) the Vehicle Segment. (Ex. 1005 at 23; Ex. 1017 at 22). ARES was developed according to specifications advanced by BN and Rockwell. Rockwell manufactured some components for the ARES system and railroad equipment suppliers including Pulse Electronics, Union Switch and Signal, Harmon Electronics, and Wabco (now Wabtec) and avionics suppliers such as Trimble Navigation and King Air supplied other components of the ARES system. (See Ex. 1005 at 23; Ex. 1017 at 22).

29. Among other features, ARES used Wayside Interface Units (WIUs) for communications between wayside devices on the one hand and onboard and control center computers on the other hand. (Ex. 1010 at vi).

30. Wayside equipment (which includes the wayside devices I mentioned above) in the ARES system includes things like trackside sensors and actuators as well as WIUs which connect them to the regional control center via the communications network. The sensors monitor such things as switch positions, track integrity, hot bearing detectors, over-switch (OS) circuits, etc. These devices were configurable devices in the sense that they had a handful of different potential states, or configurations, and the configuration or state of the device would be of critical importance to approaching locomotives. For example, it would be of critical importance for a PTC system to know the configuration of an upcoming switch to ensure the locomotive proceeds on the desired path. Powered switches would also be remotely operated from the regional control center. A WIU may connect to the communications network via either ground lines or a VHF radio. (Ex. 1012 at 3-4)

31. The WIUs specified for the ARES project were devices that would take information (including information about wayside components' configurations) from electrical and electro-mechanical components

alongside the track and convert it, using a modem, into digital signals to be transmitted via data radios or wire lines to the rail operations control system (ROCS). The WIUs would also receive digital information from the ROCS and convert it into electrical signals to activate devices, such as switches, along the track.

32. The ARES ROCS could receive "over switch clear message[s] from wayside track indicator[s]." and transmit them to the Train Situation Indicator (TSI) in the locomotive cab. (Ex. 1010 at 25). An over switch clear message indicated that an upcoming switch was in the expected position. ARES could also display one or more signals in its track plan view on the TSI screen. (Ex. 1010 at 32-33). Specifically, ARES illustrated signal locations, wayside detectors, grade crossings, and track crossings in the track plan view on the TSI screen. (Ex. 1010 at 38-39).

33. Between 1987 and 1995, the Canadian National ("CN") Railroad conducted three ATCS test or pilot projects. (Ex. 1005 at 21; Ex. 1017 at 20). The third project involved a transponder-based system that used the AAR ATCS specifications as the foundation of its architecture. (Ex. 1005 at 21; Ex. 1017 at 20). The territory on which the system was equipped included thirteen (13) sidings equipped with power switches monitored and controlled by Wayside Interface Units. (Ex. 1005 at 21; Ex. 1017 at 20). Switches

were controlled primarily through the locomotive, either automatically or through locomotive engineer action, depending on the authority under which the train was proceeding. (Ex. 1005 at 21; Ex. 1017 at 20). The position of each switch was communicated to the locomotive for display in the cab of the locomotive. (Ex. 1005 at 21-22; Ex. 1017 at 20-21). CN's version of ATCS included equipment that enforced permanent, temporary, and turnout speed restrictions by automatically applying the train's brakes. (Ex. 1005 at 22; Ex. 1017 at 21). The system also predictively enforced improperly-set switches. (Ex. 1005 at 22; Ex. 1017 at 21).

34. In 1995, the Michigan Department of Transportation received funding from the Federal Railroad Administration and contracted with Harmon Industries for it to develop an Incremental Train Control System ("ITCS") on Amtrak's line between Kalamazoo, MI and Porter, IN. (Ex. 1005 at 25; Ex. 1017 at 24). ITCS consisted of a Wayside Equipment Segment, a Communications Segment, and a Locomotive Segment. (Ex. 1005 at 25; Ex. 1017 at 24) The Locomotive Segment included an OBC, which continuously calculated braking distances to targets, monitored speed and upcoming speeds, and initiated full-service braking in the event speed or stop restrictions were violated. (Ex. 1005 at 26; Ex. 1017 at 25)

35. The Wayside Equipment Segment incorporated the existing wayside signals and added to them WIUs to enable the wayside signals, trains, and grade crossing warning devices to communicate with one another. The ITCS system was tested on Amtrak's Michigan line starting in 1995. (Ex. 1005 at 25-26; Ex. 1017 at 24-25).

36. The Amtrak Michigan line had numerous grade crossings, which were activated by track circuits. Amtrak desired to increase the speed of trains along this line from 79 to 110 miles per hour, which meant that the grade crossing signals had to be activated when the trains were further away from the crossings. Harmon's approach was to have the train transmit its passage of a specific location via a data radio to a WIU at the grade crossing, which would then provide the electrical signal to activate the crossing gate. When the gate was down, it would send a signal through the WIU and data radio to the locomotive to confirm to the locomotive that it was safe to proceed at 110 mph.

37. By the late-90's, existing systems permitted trains to communicate with configurable devices along the wayside, both through messages sent directly from the train to the configurable device, as well as through messages sent from the train to a WIU that communicated with a configurable device. Data about the configuration of such wayside configurable devices could be

used to control train movement and maintain safe operation based on the determined states of these devices.

U.S. PATENT NO. 6,996,461

38. The '461 Patent is titled "Method and system for ensuring that a train does not pass an improperly configured device." (Ex. 1001).

39. I have been asked to assume (and I have assumed) for the purposes of my analysis that the '461 Patent has an effective filing date of October 10, 2002. I have therefore tried to offer opinions in this declaration through the eyes of one of skill in the art (as defined below in Paragraph 43) as of October 10, 2002. In particular, the technological background I have provided above all occurred prior to the October 10, 2002 date, and would generally have been within the knowledge based of a person of skill in the art.

40. The '461 Patent discloses a train safety system that includes a controller and a transmitter on a train. (Ex. 1001 at 2:33-38; 2:66-3:6). The controller sends a message to a configurable device, listens for a response, and allows the train to proceed if a correct response is received; otherwise, the train is stopped. (Ex. 1001 at 5:51-65). The controller also confirms that the responsive message comes from the correct device, i.e., the device the original message was sent to. (Ex. 1001 at 5:66-6:2). The responsive

message includes information related to the direction of a switch or the activation state of a crossing gate. (Ex. 1001 at 5:1-15).

41. As I describe below, train control systems that communicate with devices along the wayside and receive responsive messages indicating the state of elements along a track, such as grade crossings, were described in the prior art references I was asked to review, confirming my general experience that such features were well-known in the art by the early 2000s.

LEVEL OF SKILL IN THE ART

42. I was asked to provide my opinion about the experience and background a person of ordinary skill in the art of the '461 Patent would have had as of October 10, 2002.

43. In my opinion, such a person of skill in the art would have had at least an undergraduate degree or the equivalent and at least five (5) years of experience in train operations or train control systems. Such a person of skill in the art would have also known about train control systems, train safety systems that include wayside systems, and train communication systems, and would have had a general understanding of how to search available literature on those topics.

44. I believe that I was a person of ordinary skill in the art as of October 10, 2002. Furthermore, I believe that I can opine today about what those of skill in the art would have known and understood as of October 10, 2002.

OVERVIEW OF THE PRIOR ART REFERENCES

Petit

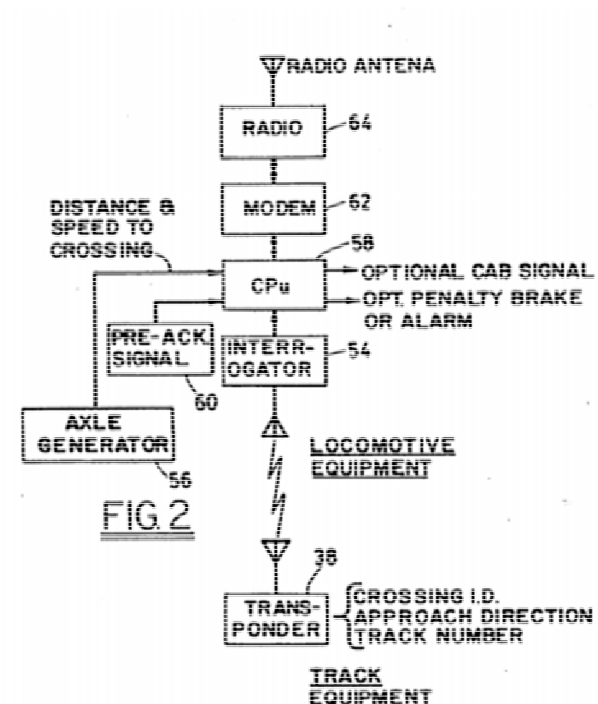
45. As part of my work in this proceeding, I was asked to review U.S. Patent No. 5,092,544 to Petit et al. ("*Petit*") (Ex. 1008).

46. *Petit* is titled "[h]ighway crossing control system for railroads utilizing a communications link between the train locomotive and the crossing protection equipment," and is generally directed to communications between a train and a crossing controller, where the crossing controller sends an acknowledgement message in response to the message from the train. (Ex. 1008 at Abstract).

47. *Petit* describes a control system that prevents trains from moving into a crossing unless the protection equipment at the crossing indicates that it is safe for the train to enter. (Ex. 1008 at 1:59-65). The system controls crossing protection equipment and any trains that are approaching the equipment in order to provide vital (i.e., fail-safe) operation of both the equipment and the trains. (Ex. 1008 at 1:9-12). The highway crossing

protection equipment may include warning lights or crossing gates. (Ex. 1008 at Abstract).

48. *Petit* discloses that a transponder along the wayside communicates via radio with an interrogator on the train, which activates and powers the transponder so that the transponder can communicate messages to the interrogator. (Ex. 1008 at 4:4-6). The transponder, in response to being energized by the passing train, sends a message to the interrogator on the train. (Ex. 1008 at 2:31-34).



(Ex. 1008 at Fig. 2)

49. In particular, the message from the transponder contains data representing the identity of the upcoming crossing (i.e., crossing I.D.), the direction the

train is coming from (*e.g.*, west or east), the track number, and the distance to the crossing. (Ex. 1008 at 4:3-13).

50. Upon receiving the message from the transponder, *Petit* explains that the CPU on the train transmits a message to a crossing identified by the transponder message that includes the locomotive I.D., speed, direction of approach, and distance from the crossing. (Ex. 1008 at Fig. 5B). *Petit* discloses the CPU establishes a communications link with the crossing gates so that the train can send and receive messages to and from the crossing gates. (Ex. 1008 at 4:32-34). The messages include an identifier from the configurable device and may further include data indicating the status of the device. (Ex. 1008 at 5:12-14; 7:67-8:8).

51. The "[m]essages are handled through vital processing indicated in one operation block 84 entitled 'Perform Safety Checks' which are carried out by a vital processor or logic . . . . If the result of the process is an error in the message which, of course, is indicative of a communications failure or a failure in a component of the system, the output to set the brakes or alarm is activated. The train may then be stopped or allowed to proceed at a restricted speed until the failure is corrected." (Ex. 1008 at 5:63-6:8). The vital checks ensure that the messages are received by and sent from the intended devices, as well as ensuring that the content of the message is

maintained throughout the transmission of the message. If such a response is not received in a timely manner, movement across the highway is not permitted. After a delay, the brakes will be applied unless an appropriate response message is received indicating that the device is in a safe configuration.

52. In *Petit*, the crossing validates that the messages, which include the crossing I.D., were intended for the specific crossing during a vital check. (Ex. 1008, Claim 7, Claim 11). This vital check ensures that the origin, destination, and content of a message are accurate. After the crossing performs a vital safety check, it transmits a response back to the train. (Ex. 1008, 5:23-25; 5:41-48). These response messages are each coded with the identity of the approaching train so that the response messages are addressed exclusively to the approaching train. (Ex. 1008, Claim 9). *Petit* also teaches that vital safety checks can be performed at various points in the program, such that vital safety checks may be on the train or at the crossing. (Ex. 1008, 5:67-6:1).

53. The communication protocol of *Petit* leads me to conclude that the communication disclosed by *Petit* occurs directly from the train to the crossing. The messages are addressed to the train or the crossing, without any additional addresses of intervening equipment. Moreover, there is no

mention in *Petit* of any WIUs or other routing hardware to control the flow of communication. These two things alone would lead me to believe that the system of *Petit* was directed towards direct communication from the train to the crossing. However, *Petit* also employs a beacon transponder which ensures that the train is notified of an upcoming crossing at the time that the message is to be sent. This transponder triggers the sending of the message only when the train is within reception distance (based on the physical location of the transponder) of the upcoming crossing. Accordingly, the communication protocol of *Petit* ensures direct communication from the train to an upcoming crossing.

54. As I noted above, the messages sent to the crossing include a crossing I.D. which distinguishes the device from other crossings along the track. (Ex. 1008 at Claim 6). Likewise, the message sent from the transponder to the train necessarily includes a crossing I.D. (this is the source for the crossing I.D. in the message sent by the train to the crossing). A person of skill in the art would understand that other messages involved in *Petit's* communication protocol could or would also contain a crossing I.D., for example, to provide an additional check at the train upon receipt of the crossing's response. A person of skill in the art would understand that this could prevent a dangerous condition from occurring when, for example, a train believes a

crossing is in a "safe" or down position and proceeds as such, but where the information received by the train in fact described a different crossing. The onboard CPU of *Petit* is able to validate messages and conditions of trackside devices and to perform vital determinations about when to apply the brakes; at least since the onboard CPU is the last processor that makes such a determination in *Petit*.

55. These messages are targeted messages, and both the locomotive and the crossing can verify that the device with which communication is occurring is the correct, and expected, device. The CPU can control the train's brakes. (Ex. 1008 at 4:49-51). The CPU prevents the train from moving into a crossing unless the grade warning system is in a safe condition. (Ex. 1008 at 1:63-65). A conforming message from highway crossing equipment is necessary to provide movement authority to a train. (Ex. 1008 at 8:37-39). *Petit* also discloses that in a first state, the equipment allows highway traffic across the tracks; the system establishes a communications link between the equipment and any trains approaching the equipment. (Ex. 1008 at 2:2-6). In a second state, the equipment then prevents traffic from crossing the tracks.

56. *Petit* discloses "means for stopping [the] train and operating [the] equipment to its second state when [the] vital checks indicate an error in [the] messages." (Ex. 1008 at Claim 25).

57. *Petit* describes a brake operation that "is referred to as a penalty brake, since braking is the result of either a failure in the system, or a failure to establish a communication link or the failure to pre-acknowledge or communicate with the transponders after a pre-acknowledge, if the optional pre-acknowledgement is included in the system." (Ex. 1008 at 4:51-57). The train's brakes will be applied by the safety system if the gates are not closed or if there is a communications failure or error between the train and the grade crossing.

58. If during the vital safety check, the CPU determines an error exists with the message, it assumes an unsafe condition and prevents the train from passing the crossing by stopping the train before it reaches the crossing. (Ex. 1008, 5:63-6:8). Likewise, if the onboard CPU determines that the crossing is in an impermissible configuration, it can stop the train consistent with that determination. (Ex. 1008, 5:63-6:8).

59. *Petit* further discloses that the system may employ worst-case braking curves. The system may also base braking curves on distance, either dynamically calculated or predetermined. The distances used "depend upon

conditions around the crossing such as grades and the maximum speeds of the trains and minimum braking rate of the train." (Ex. 1008 at 3:49-52).

60. *Petit* describes a process for dynamically calculating braking curves based on current speed and current distance from a crossing, in which update messages are communicated between the crossing and the train, and the brakes are not applied even if a communication failure occurs because the crossing controller will drop the gates in response to the failure. (Ex. 1008 at 7:9-19). Further factors in dynamically calculating a braking curve may include train length, weight, track gradient and curvature, and location of the train on the track.

61. *Petit* discloses a CPU with an output port that "is connected to drive the controller of a brake or to actuate the train's brakes or an alarm." (Ex. 1008 at 4:49-50). Communication failure, brake application, or alarm actuation are corrected by acknowledgement of a speed restriction, signal issue correction, or communication reestablishment.

62. In the event of multiple track crossings, the onboard CPU of *Petit* receives multiple messages and a worst case minimum time to approach will be used to determine whether to apply the brakes. (Ex. 1008, 7:47-50). This "worst case" assumption is dynamically calculated based on the train's speed and an assumption about deceleration rate to determine a currently-relevant braking

distance. (Ex. 1008, 7:9-19). This provides the amount of braking time necessary for safe train operation. *Petit* confirms this with its disclosure that braking distances will depend upon conditions around the crossing such as grades and the maximum speeds of the trains and minimum braking rate of the train. (Ex. 1008, 3:49-52).

63. *Petit* further discloses that the CPU can actuate both the brakes (as described above) and an alarm. (Ex. 1008, 4:49-50). An application brakes or actuation of an alarm may be corrected by acknowledgement of a speed restriction, correction of a signal issue, or reestablishment of communication.

Blesener

64. As part of my work in this proceeding, I was asked to review PCT Publication No. 02/091013 to Blesener et al. ("*Blesener*") (Ex. 1007).

65. *Blesener* is titled "[a]utonomous vehicle collision/crossing warning system and method" and is generally directed to a safety communication system that includes deployed units and a vehicle with a local database of components in the system. (Ex. 1007 at Abstract). *Blesener* discloses deployed units that, after receiving a message from a locomotive, communicate unit status back to the locomotive. (Ex. 1007 at p. 3, ll. 4-6; p. 7, ll. 15-17, p. 12, ll. 14-25).

66. *Blesener* describes an onboard database that organizes the location and type of crossings and other configurable devices that a train encounters along a trackside. (Ex. 1007 at p. 10, ll. 22-26). The database provides the location of all configurable devices the train may encounter to the locomotive control systems. A two-way communications link is established between the locomotive and the crossings. (Ex. 1007 at p. 3, ll. 26-27). A controller directs message transmissions to nearby crossing warning systems. (Ex. 1007 at p. 15, ll. 6-7).

67. *Blesener* discloses a Smart Self Updating System (SSUS) that polls crossings and shares the latest information. (Ex. 1007 at p. 10, ll. 5-6). This includes receiving response messages from crossing systems that contain, among other things, status information about the crossing systems. *Blesener* teaches that a controller receives messages indicating the status of the configurable device. (Ex. 1007 at p. 15, ll. 24-25).

68. *Blesener* discloses that a GPS receiver in the locomotive determines the train's position, while GPS receivers at each railroad crossing provide the location of each crossing. (Ex. 1007 at p. 3, ll. 11-14). Whenever a locomotive interacts with a crossing, the system compares the databases to determine which has the latest information, then transfers that information to the other. (Ex. 1007 at p. 10, ll. 22-25). Locomotives do not need to know

the location of crossing beforehand because each crossing is activated by the approaching locomotive's beacon, transmitting information about its location to the locomotive, which learns of its existence and adds the location information to the locomotive's database. (Ex. 1007 at p. 12, ll. 20-25). Accordingly, the locomotive knows where each crossing is, and failure to receive information from the crossing will cause the system to notice the malfunction.

69. *Blesener* teaches that the system is capable of distinguishing devices from one another based on their geographic location. (Ex. 1007 at p. 12, ll. 15-16). By knowing where the crossing is located relative to the locomotive, the system is capable of verifying whether it is approaching a crossing and cross-check that information with whether it has received confirmation that the crossing is activated. (Ex. 1007 at p. 12, ll. 16-18). In my opinion, the *Blesener* methodology uses location information as a crossing identifier akin to the crossing I.D. I discussed above from *Petit*.

70. *Blesener* discloses that the system uses GPS to determine the locomotive's distance from an individual crossing. The controller generates a BEACON broadcast that is used to calculate crossing arrival and departure. The BEACON conveys identification information and the controller collects and

stores status data from working crossings and relays fault notifications from failed crossings. (Ex. 1007 at p. 14, ll. 6-13).

71. *Blesener* also discloses that the locomotive's speed and the distance at which the radio network communicates provide a margin of several minutes between the time the controller wakes up and the crossing activates. In an example embodiment, the controller uses 2 watts of power to send, via the beacon, a message to the crossing containing information related to the locomotive's power, speed, and position. Alternatively, the controller either sends an acknowledgement message or uploads data to the locomotive database. At low power, the locomotive may receive three types of messages: crossing activated/deactivated, upload data, or MAYDAY signals. At the crossing, messages received include: enter standby mode, activate warning and provide acknowledgement, or deactivate warning and acknowledge. (Ex. 1007 at p. 15, ll. 19-26). The locomotive sends and receives messages from the crossing equipment which include information about the status of the crossing equipment.

72. The system of *Blesener* bases an arrival calculation based on the speed, location, and time from the crossing. Such a calculation may take the form of distance being equal to speed times time, a known calculation of linear motion. By knowing any two of those variables, the third can be

determined. A threshold based on one of the variables, such as time, can be adapted to be based on any of the other two (distance or speed) if at least two of the three variables are known (speed, distance, or time). For example, if a system knows that a train is moving at 60 miles per hour, and the train is one mile away, the train can calculate that it will arrive, based on current speed, in one minute. By that same logic, if the train knows it is traveling at 60 miles per hour, and that it will arrive in one minute, the train can calculate, based on current speed, that it is one mile away.

RSAC

73. As part of my work in this proceeding, I was asked to review the Report of the Railroad Safety Advisory Committee to the Federal Railroad Administrator entitled "Implementation of Positive Train Control Systems" (September 8, 1999) ("*RSAC*") (Ex. 1005). *RSAC* was submitted to Congress attached to a letter report from FRA Administrator Jolene Molitoris on May 17, 2000, after being approved by the Office of the Secretary of Transportation and the Office of Management and Budget at the White House. *RSAC* generally describes the contemporary state of PTC technology and outlines the various tests and pilot projects that had been and were being conducted by the North American railroads as of 1999. (Ex.

1005). *RSAC* represents a subset of the knowledge of the PTC industry as of its complication.

74. I served as the Director of the Office of Research and Development of the Federal Railroad Administration from 1995 until 2003 in Washington D.C. and oversaw the operations of the Research and Development library as part of my duties.

75. In furtherance of these duties I ensured that reports received by the library were appropriately handled and made available to the public.

76. In late 1999, I, in my capacity as the Director of the Office of Research and Development of the FRA, including my role of overseeing the operations of the FRA Research and Development library, received a report entitled "Report of the Railroad Safety Advisory Committee to the Federal Railroad Administrator: Implementation of Positive Train Control Systems" dated September 8, 1999 ("the Report"). I am aware of this because as part of my duties as the Director of the Office of Research and Development of the FRA I saw the copy of the Report that was received.

77. I reviewed the Report and paid particular attention to the Positive Train Control ("PTC") projects with which I had been personally involved in and the FRA had helped fund, specifically Positive Train Separation ("PTS"), Incremental Train Control System ("ITCS"), Advanced Civil Speed

Enforcement Systems ("ACSES"), the Alaska Railroad Corporation Project ("ARRC"), Illinois Department of Transportation ("IDOT") Positive Train Control Project, Highway-Rail Grade Crossing Safety, Corridor Risk Assessment Model ("CRAM"), and Nationwide Differential Global Positioning System ("NDGPS").

78. At that time, I directed my administrative assistant to stamp the report with the "Property of FRA Research & Development Library" stamp and to place the Report into the library. This was how the Office of Research and Development routinely received technical reports and placed the same into the FRA Research & Development Library. The report was then considered received into the Federal Railroad Administration's Research and Development Library. I was responsible for ensuring that the stamp was applied to the Report.

79. The Federal Railroad Administration's Research and Development Library was open to the public and the Report was, around the end of 1999, publically available through the library.

80. I was asked to review Ex. 1017. Upon review, Ex. 1017 looks to be the same as the Report that I saw in 1999. In particular, I noticed the stamp from the Federal Railroad Administration's Research and Development

Library on the last page of Ex. 1017. I believe that Ex. 1017 is an accurate copy of the Report that the library received (and I reviewed) in late 1999.

81. At the direction of counsel, I have been asked to cite to both Ex. 1017 and Ex. 1005, and accordingly have done so.

82. *RSAC* discloses systems for controlling trains based on communications with wayside equipment. (Ex. 1005 at 38; Ex. 1017 at 37). More specifically, an OBC establishes a communications link with a crossing and is configured to control the train's braking systems. (Ex. 1005 at 25-26; Ex. 1017 at 24-25). If a crossing indicates that it is not functioning as intended, the OBC initiates a full service brake. (Ex. 1005 at 26; Ex. 1017 at 25). The messages sent by the OBC to a particular crossing include data related to the identity of the crossing to distinguish it from other crossings along the track. (Ex. 1005 at 35; Ex. 1017 at 34).

83. *RSAC* describes the direction major railroads were taking at the time of publication to comply with new federal safety standards, including the development of collision avoidance systems. (Ex. 1005 at vii; Ex. 1017 at v). Systems described include the Incremental Train Control System (ITCS), Advanced Railroad Electronics System (ARES), Advanced Civil Speed Enforcement System (ACSES), and other PTC systems. (Ex. 1005 at 25, 23, 27 and 38; Ex. 1017 at 24, 22, 26 and 37).

84. *RSAC* discloses that ITCS includes an OBC that controls the computerized train systems, including brake systems, communications systems, and displays. (Ex. 1005 at 25; Ex. 1017 at 24). The OBC establishes a session with each wayside interface unit (WIU). (Ex. 1005 at 25; Ex. 1017 at 24). WIUs may include switches and highway rail grade crossings, and may be connected to a Wayside Interface Unit-Server (WIU-S) to further enable communication between the WIUs and the train. (Ex. 1005 at 25-26; Ex. 1017 at 24-25). Messages sent from WIU-Ss include signal indication data, switch position data, certain track circuit status data and status data from each crossing where advance start operation is used. (Ex. 1005 at C-4; Ex. 1017 at C-4).

85. *RSAC* discloses that for any active grade crossing identified on the profile, the OBC continuously calculates an expected time of arrival at the crossing, expressed in seconds remaining before arrival. When this time reaches 100 seconds, the OBC transmits the estimate to the specified crossing. (Ex. 1005 at C-5; Ex. 1017 at C-5). To accomplish this, a person of skill in the art would know that the OBC is in communication with a transceiver (a radio transmitter/receiver) located on the train.

86. *RSAC* also discloses that through a self-diagnosing process, the system is capable of determining whether the crossing warning system is operating as

intended. If so, the train continues at maximum authorized speed; if not, the train must slow to a predetermined speed. (Ex. 1005 at 38; Ex. 1017 at 37).

87. *RSAC* teaches that if the crossing warning system has been operational for five minutes or more when no train is present (i.e., a false activation has occurred), the train will be restricted to a speed of 15 mph when travelling through the grade crossing due to the probability that highway users have ignored the activation of the warning system. (Ex. 1005 at 38; Ex. 1017 at 37).

88. *RSAC* discloses that if the crossing WIU indicates that the crossing is armed and functioning as intended, the train may proceed at maximum speed and the crossing will provide the required 30-second warning. (Ex. 1005 at 26; Ex. 1017 at 25). If a crossing indicates that it is not functioning as intended, a full service penalty brake may be initiated. (Ex. 1005 at 26; Ex. 1017 at 25). The OBC can miss up to two broadcasts without adverse effects, but if it misses a third (i.e., 18 to 20 seconds elapsed time), indicating a message failure, an automatic brake application stops the train. (Ex. 1005 at 26; Ex. 1017 at 25).

89. *RSAC* discloses that ITCS monitors the health of highway grade crossings and enforces speed restrictions if a grade crossing is not activated. (Ex. 1005 at B-6; Ex. 1017 at B-6). A key feature of PTC systems is collecting

all available information about potential targets (e.g., configurable devices), verifying that the sources of information are valid, and ensuring that the information about the targets is sufficient. (Ex. 1005 at C-15-C-16; Ex. 1017 at C-14-C-15). Such information includes information sufficient to allow the OBC to identify the specific crossing.

90. *RSAC* describes a database, stored on the OBC, which includes information on signal indications, track curvature, gradients, mileposts, civil speed limits, speed restrictions, and the locations of all devices which the train may need to communicate with. The OBC continuously calculates braking distances to targets, monitors current speed and upcoming speeds, and initiates a full service penalty brake if the maximum authorized speed is violated or if the train is not properly slowed for an upcoming speed restriction or stop requirement. (Ex. 1005 at 26; Ex. 1017 at 25).

91. *RSAC* also describes other PTC systems that include a GPS receiver connected to an OBC with a track database. The OBC performs data processing to monitor location, calculate braking curves, determine speed, receive authority limits, and apply the brakes if the authority or speed limits are projected to be exceeded. These systems include an OBC that transmits position data and violation messages off the train. (Ex. 1005 at 24; Ex. 1017 at 23).

92. *RSAC* discloses that ITCS calculates and displays the distance to targets, the type of targets, and restrictions associated with those targets. (Ex. 1005 at 26; Ex. 1017 at 25). The OBC calculates braking curves. (Ex. 1005 at 24; Ex. 1017 at 23). The braking curve can be very sophisticated or can be a simple, worst-case train/grade braking curve. (Ex. 1005 at C-15; Ex. 1017 at C-14). A simple braking curve incorporates a worst case braking distance or time, while a sophisticated braking curve incorporates the weight of each car in a train and the grade each car sits on at any given time.

93. *RSAC* also discloses that the OBC tracks train weight and weight distribution. (Ex. 1005 at B-4; Ex. 1017 at B-4). The system may require acknowledgement from the train operator. (Ex. 1005 at B-5; Ex. 1017 at B-5). This acknowledgement forestalls enforcement of a command or a speed reduction. (Ex. 1005 at B-5; Ex. 1017 at B-6). Without acknowledgement from the train operator, command or speed reduction enforcement will occur. Such commands include full stops or speed restrictions of zero miles per hour.

94. In my opinion, a person of skill in the art would have understood *RSAC* as describing several then-existing PTC systems and their various features. Given the similarity of these features and the nature of *RSAC* as a summary of existing systems, those of skill in the art would have been motivated to

combine the features of the various systems described in *RSAC*, and would have expected the systems to be able to have features from other systems incorporated therein with minimal experimentation and re-engineering.

SUMMARY OF OPINIONS

95. As discussed in more detail below, my review of prior art documents in this proceeding demonstrates that, in general, the concepts of the '461 Patent were not new as of October 10, 2002.

96. My review of the documents referenced in the preceding section comports with my experience that those of skill in the art prior to 2002 knew of the use of PTC systems capable of communicating with grade crossings and enforcing stops if the crossings are not properly configured. Specifically, *Petit* discloses a system in which crossing controllers communicate acknowledgement messages to approaching trains for the fail-safe operation of both. *Blesener* describes a system in which grade crossings and locomotives communicate status and geographic information with one another and in which the locomotive is capable of calculating arrival times to the crossings. *RSAC* describes several PTC systems in which trains communicate with devices along the wayside, such as grade crossings, and that include OBCs that enforce emergency stops in the event grade crossings do not function as intended. Thus, all these references recognize the

importance, well-known to those of skill in the art, of operating locomotives armed with the knowledge of the state of upcoming configurable devices.

97. Moreover, the combinations I was asked to consider in the instant proceeding (i.e., *Petit* combined with *Blesener*, *RSAC* combined with *Blesener*, and *RSAC* combined with *Petit* and *Blesener*) could and would have been made by a person of ordinary skill in the art as of October 10, 2002.

COMBINATIONS

Reasons to Combine

98. I have been told that combinations of the prior art should be analyzed based on the mindset of one of skill in the art at the time the invention was made. Counsel has advised me that in rendering my opinions, I should cast my mind back to the time the invention was made to occupy the mind of one skilled in the art who is presented only with the references, and who is normally guided by the then-accepted wisdom in the art.

99. I understand that I am to perform the task referenced in the preceding paragraph without using "hindsight" reasoning. Instead, I was asked to consider the feasibility and combinability of references through the eyes of a person of skill in the art as of October 10, 2002. As I describe below, the individual references, which are all attributable to well-known players in the

train safety and automation space in the 1990's and early 2000's, contain statements and teachings that motivate those of skill in the art to look to the other references in the combinations I was asked to consider.

100. I understand that relevant considerations for combining references include at least the following:

(A) Combining prior art elements according to known methods to yield predictable results;

(B) Simple substitution of one known element for another to obtain predictable results;

(C) Use of known techniques to improve similar devices, methods, or products in the same way;

(D) Applying a known technique to a known device, method, or product ready for improvement to yield predictable results;

(E) "Obvious to try" – choosing from a finite number of identified, predictable solutions with a reasonable expectation of success;

(F) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art;

(G) Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

101. I have kept these considerations in mind when offering the opinions below regarding combinability. As explained below, it is my opinion that those of skill in the art would have combined (1) *Petit* and *Blesener* (2) *RSAC* and *Blesener* and (3) *RSAC*, *Petit*, and *Blesener*.

***Combining* Petit *with* Blesener**

102. I have been asked to consider the technical feasibility and implications of combining *Petit* with *Blesener*. In my opinion, a person of ordinary skill in the art would have been motivated to combine these references and would have been readily able to combine them with an expectation of success.

103. It is my opinion that a person of skill in the art would be motivated to combine *Petit* and *Blesener* to ascertain and develop a train safety system including a control unit and a transceiver. The teachings of *Petit* and *Blesener* would have motivated a person of skill in the art to configure the control unit to transmit interrogation messages, listen for a response, and stop the train if the response is non-compliant. *Petit* teaches a system for controlling crossing protection equipment and trains that are approaching the equipped crossing so as to provide vital (fail-safe) operation. (Ex. 1008 at

1:9-12). *Blesener* teaches a low power, decentralized crossing warning system with communication between a train and the crossing equipment. (Ex. 1007 at p. 1, ll. 12-16).

104. *Petit*, as I described above, discloses a system for controlling both crossing protection equipment and trains that are approaching the equipped crossing to provide vital operation. (Ex. 1008, 1:9-12). *Petit* provides for an onboard CPU that establishes a communications link with a crossing gate and is configured to actuate a train's braking systems if the detected conditions warrant it. (Ex. 1008, 4:32-34, 4:49-51). In *Petit*, a conforming message from highway crossing equipment is needed to provide movement authority to a train. (Ex. 1008, 8:37-39). *Petit* uses the train's OBC and hardware along the wayside to perform these operations. (Ex. 1008, 2:35-36). And *Petit* relies on the crossing to confirm that it matches the crossing I.D. contained in the interrogation message from the train. (Ex. 1008, 5:63-6:8).

105. In seeking to improve upon the system of *Petit*, a person of ordinary skill in the art would have been motivated to take advantage of the fact that the onboard CPU is already a vital component and minimize the need for additional vital trackside hardware by consolidating the vital functions onboard the train. This would eliminate, or at least reduce, additional interfaces (particularly over-air interfaces) where message failures could

occur. *Blesener* reflects this motivation, as it suggests that moving the computational responsibility to the onboard computer. *Blesener* further explains that an onboard database of configurable devices permits such a modification. Indeed, in my opinion, it is this database that provides the onboard CPU with the information that, in *Petit*, is received from the transponder (including crossing I.D.). By centralizing all of the vital processing logic from *Petit* onto the train, as suggested and enabled by *Blesener*, the possibility that messages, indicating issues or failures, are not received is greatly reduced. The possibility of a failure in communication with a transponder (and thus a failure on the train to obtain an identity of the crossing) is also minimized, as the data about upcoming crossing equipment is stored onboard. This result ensures that the combined system can apply the brakes more consistently when needed.

106. *Blesener* provides for an onboard database that organizes the location and type of crossings and other configurable devices that a train may encounter along its path. (Ex. 1007 at p. 10, ll. 22-26). In the combined system, in view of *Blesener*, the *Petit* OBC no longer needs to rely on trackside beacons to provide an indication of approaching configurable devices, instead the GPS and database alert the OBC of upcoming configurable devices.

107. The identities of upcoming configurable devices are contained in the onboard database. Using a GPS and the predetermined coordinates (of the devices) and calculated coordinates (of the train), the onboard CPU of *Petit* would store the location of the next configurable device, as in *Blesener*, and the onboard CPU can communicate with upcoming configurable devices. The combination of *Petit* with *Blesener* would be advantageous in that it eliminates the need to have beacon transponders associated with each configurable device. It is also advantageous in that it moves all the vital processing onboard the train to a CPU which must be fail-safe anyways.

108. The teachings of *Blesener* would have motivated the modification of *Petit* such that the onboard CPU of *Petit* would transmit interrogation messages to configurable devices, listen for a response, and stop the train if the response is non-compliant to ensure heighted safety. In particular, the initial communication of *Petit* would be achieved in the combined system by using *Blesener's* teaching that an onboard database of configurable devices, combined with up to date GPS location information, allows an OBC to monitor for and communicate with upcoming configurable devices. In fact, *Blesener's* specific teachings suggest to me that *Blesener* would reduce the wayside hardware requirements of *Petit* in this way. (Ex. 1007 at p. 2, ll. 22-25).

109. The onboard CPU would have *Blesener's* database of configurable devices stored on the train and would handle the vital task of confirming the identity of the communicated-with configurable device. In the modified system the configurable device would send back not only a configuration (as is explicitly described in *Petit*) but also its identifier (which *Petit* discusses as residing in the configurable device to permit comparison with the received identifier). (Ex. 1008, 5:63-6:8). The onboard CPU would then verify both the configuration of the configurable device and its identity as part of the vital safety check, to determine whether to activate the brakes.

110. This arrangement consolidates all of the vital functioning of the system in the train's CPU. The onboard CPU, as it is connected to the train's braking operation, must be a vital system. This reduces the processing requirements of the configurable devices to just providing an identifier and a state in response to an interrogation message. It also reduces the need to validate the vitality of both onboard equipment and all of the trackside equipment. Thus the modification substantially reduces the costs associated with ensuring that a minimal amount of hardware is validated as vital.

111. A train needs to know the identity of the next grade crossing it is approaching. To do this, it may send a notification to that grade crossing to lower the gates, and may receive a notification from the crossing that the

gates were lowered thus enabling the train to cross the grade crossing at maximum authorized track speed. If the notification came back from the crossing that the gates had not lowered, the train would have to reduce its speed before crossing the grade crossing.

112. *Blesener*, in this regard, represents one known solution to a known problem of hardware based triggers for the sending of messages from a train to an upcoming wayside device to ascertain whether it was safe to pass the upcoming device. *Blesener* more generally represents a known solution to the known problems associated with distributing vital processing functionality along several disparately located CPUs.

113. Combining the transmission of an interrogation message to a grade crossing and the application of a train's braking system as disclosed by *Petit* and further with the database organizational structure described in *Blesener* would have improved the system of *Petit* by incorporating the features of *Blesener* and would have been trivial to one of ordinary skill in the art.

114. The combined resulting system of *Petit* and *Blesener* would include an onboard database containing the locations of devices along the route and would be connected to a GPS receiver for determining the location of the train. The train, approaching an upcoming configurable device (*e.g.*, a switch or crossing), would use its OBC to send a message directly to the

upcoming device requesting a status of the device. The message would include a target identifier and an origination identifier. The target identifier would ensure that only the proper device responded and the origination identifier would be used by the configurable device to address a response message. The device would then send a reply message directly back to the train that included a target identifier (that of the train), an origination identifier (that of the device), and a configuration of the device. The train would then be able to determine if it was safe to proceed based on the response or lack thereof from the device.

115. Accordingly, in my opinion, a person of skill in the art would have been motivated to combine *Petit* with *Blesener* and would have done so with an expectation of success.

***Combining* RSAC *with* Blesener**

116. I have been asked to consider the technical feasibility and implications of combining *RSAC* with *Blesener*. In my opinion, a person of ordinary skill in the art would have been motivated to combine these references and would have been readily able to combine them with an expectation of success.

117. It is my opinion that a person of skill in the art would be motivated to combine the teachings of *RSAC* with *Blesener* to ascertain and develop a train safety system including a control unit and a transceiver. The teachings

of *RSAC* and *Blesener* would have motivated a person of skill in the art to configure the control unit to transmit interrogation messages, listen for a response, and stop the train if the response is non-compliant.

118. *RSAC* represents the state of the railroad industry at the time of its publication. Barring any explicit disclosures within the report, one of ordinary skill in the art at the time would have been motivated to incorporate the teachings of one system disclosed within the report with another in order to incorporate the advantages of one with another to further improve upon PTC systems.

119. *RSAC* teaches a system for controlling trains based on communication with train equipment along a wayside. (Ex. 1005 at 38; Ex. 1017 at 37). *Blesener* teaches a lower power, decentralized crossing warning system. (Ex. 1007 at p. 1, ll. 12-16). A person of skill in the art interested in improving train-highway intersection safety would have been motivated by the teachings of *RSAC* and *Blesener* to develop a system containing a control unit and a transceiver, where the control unit sends a message, listens to a response, and stops the train if the response does not conform to an expected configuration. Such a system would have provided additional safety control over trains as they travel along the nation's rails; in particular, as the trains encounter switches and road crossings.

120. *RSAC* provides for an OBC that establishes a communications link with crossing gates and is configured to actuate a train's brake systems. (Ex. 1005 at 25-26; Ex. 1017 at 24-25). *RSAC* also teaches initiating a full service brake if a crossing indicates it is not functioning as intended. (Ex. 1005 at 26; Ex. 1017 at 25). *RSAC* describes including the identity of the crossing with the messages by way of a location, which distinguishes a crossing from other crossings along the track. (Ex. 1005 at 33; Ex. 1017 at 32).

121. *Blesener* provides for an onboard database that organizes the location and type of crossings and other configurable devices that a train may encounter along the trackside. (Ex. 1007 at p. 10, ll. 22-26). This level of detail is not mentioned in *RSAC*, but given the type of document it is (namely, a summary of then-existing systems), a person of skill in the art would have been motivated to seek out teachings such as *Blesener* regarding some of the more implementation-specific details needed to build such a system.

122. It is apparent that *RSAC* and *Blesener* are both directed to train safety at crossings. This leads me to the conclusion that a person of skill in the art would have readily referred to them when developing a system that includes a control unit and a transceiver, where the transceiver is configured to transmit an interrogation message to crossing equipment and the control unit

is configured to stop the train if the return message does not conform to a required set of standards.

123. By the combining the train safety systems of *RSAC* with the application of a train's braking system as also disclosed by *RSAC* and with the database organizational structure disclosed in *Blesener*, a person of skill in the art would have arrived at such a system. The person of skill in the art would have known that a train needed to know the identity of the next grade crossing it is approaching, send a notification via the transceiver to that grade crossing to lower the gates, and receive a notification from the crossing, also via the transceiver, that the gates were lowered thus enabling the train to cross the grade crossing at maximum authorized track speed. If the notification came back from the crossing that the gates had not lowered, the train would have to reduce its speed before crossing the grade crossing.

124. *RSAC* solves a long-felt need of ensuring a train would not pass a configurable device that was improperly configured. (Ex. 1005, vii; Ex. 1017, v). *RSAC* further describes the direction that the major railroads were taking at the time to comply with newly required federal safety standards at the time, including collision avoidance systems. (Ex. 1005, vii; Ex. 1017, v).

125. *Blesener* provides specifics of how certain features of *RSAC* could be implemented. To solve the problem that persisted from the publishing of *RSAC* in 1999 through the filing of the '461 Patent (to provide a train safety system capable of detecting the configuration of a configurable device and managing train movement based on the response) one would have looked to *RSAC* and *Blesener*.

126. The combined system would include an onboard database containing the locations of devices along the route and would be connected to a GPS receiver for determining the location of the train. The train, approaching an upcoming configurable device (*e.g.*, a switch or crossing), would use its OBC to send a message to the upcoming device through a WIU, requesting a status of the device. The message would include a target identifier and an origination identifier. The target identifier would ensure that only the proper device responded and the origination identifier would be used by the configurable device to address a response message. The device would then send a reply message back to the train, through a WIU, that included a target identifier (that of the train), an origination identifier (that of the device), and a configuration of the device. The train would then be able to determine if it was safe to proceed based on the response or lack thereof from the device.

127. Accordingly, in my opinion, a person of skill in the art would have been motivated to combine *Petit* with *Blesener* and would have done so with an expectation of success.

***Combining* RSAC *with* Petit *and* Blesener**

128. Above I described the motivation to combine *RSAC* and *Blesener* such that *Blesener* fills in the gaps suggested by the *RSAC* report. Also, I have already described why one would combine *Blesener* with *Petit* by removing the additional wayside hardware of *Petit* to further streamline and simplify the message protocols in train control systems.

129. Further, as *RSAC* represents the state of the industry regarding PTC systems, the features of one system could be used to modify another system to achieve the combined benefits of both. In an effort to improve the systems of *RSAC*, one would have looked to *Petit* to reduce the number of routing points in the flow of communication from the train to a configurable device. Each routing point indicates another possible source of failure. A direct communications system, as described by *Petit*, would have fewer points of potential failure between the configurable device and the train. It would also reduce cost, as there would no longer be a need for three devices capable of radio communication (*i.e.*, an OBC, a WIU, and a configurable device).

130. The combined system would be identical to the one resulting from the combination of *RSAC* and *Blesener*, as set forth above, except the communication between the train and the configurable device would be direct, without the routing functions of a WIU discussed in *Blesener*.

I declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true, and 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 Title 18 of the United States Code.

5 April 2017

Date

Steven R. Ditmeyer