

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SIEMENS MOBILITY, INC.,
GROUND TRANSPORTATION SYSTEMS USA INC.,
HUMATICS CORP., and PIPER NETWORKS, INC.,
Petitioner,

v.

METROM RAIL, LLC,
Patent Owner.

IPR2023-00470
Patent 8,812,227 B2

Before JAMES P. CALVE, HYUN J. JUNG, and NEIL T. POWELL,
Administrative Patent Judges.

CALVE, *Administrative Patent Judge.*

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. BACKGROUND

Siemens Mobility, Inc., Ground Transportation Systems USA Inc., Humatics Corp., and Piper Networks, Inc. (collectively, “Petitioner”) filed a petition requesting *inter partes* review of claims 1–28 (the “challenged claims”) of U.S. Patent No. 8,812,227 B2 (“the ’227 patent”) (Ex. 1001). Paper 5, 1 (“Pet.”). Metrom Rail LLC (“Patent Owner”) timely filed a Preliminary Response. Paper 10 (“Prelim. Resp.”).

We have authority to determine whether to institute an *inter partes* review. *See* 35 U.S.C. § 314 (2018); 37 C.F.R. § 42.4(a) (2022). An *inter partes* review may not be instituted “unless . . . the information presented in the petition . . . shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. § 314(a). Upon consideration of the evidence and arguments in the record, we determine that the information presented shows a reasonable likelihood that Petitioner would prevail with respect to at least one of the challenged claims. We therefore grant institution of an *inter partes* review. *See* 37 C.F.R. § 42.108(a) (“When instituting . . . review, the Board will authorize the review to proceed on all of the challenged claims and on all grounds of unpatentability asserted for each claim.”).

A. Related Proceedings

The parties identify the following proceeding involving the ’227 patent: *Metrom Rail, LLC v. Siemens Mobility, Inc.*, Case No. 1:22-cv-00049-RGA (D. Del. filed Jan. 13, 2022). Pet. i; Paper 8, 3. Patent Owner states, “IPR2023-00439, IPR2023-00452, IPR2023-00460 and IPR2023-00468 involve the same parties as this proceeding.” Paper 8, 3.

B. Real Parties in Interest

Petitioner identifies Siemens Mobility, Inc., Ground Transportation Systems USA Inc., Humatics Corp., Piper Networks, Inc., and Thales USA, Inc. as the real parties in interest. Pet. i. Patent Owner identifies Metrom Rail, LLC as the sole real party in interest. Paper 8, 2.

C. The '227 patent (Ex. 1001)

The '227 patent describes collision avoidance systems (CASs) used in the railroad industry (Ex. 1001, 1:17–18) to control maintenance equipment, vehicles, railcars, hyrail vehicles, train cars, train engines, and other rail line vehicles (*id.* at 3:43–60, Figs. 1A–1C, 2). Figure 1C depicts a hyrail vehicle that operates on railroad tracks *and roads* (*id.* at 3:50–51) and has a CAS (*see id.* at 3:52–60, Fig. 2 (vehicle 204)). The '227 patent's CAS technology may be used in other vehicles, applications, and industries where vehicle spacing, location, and status are important including the construction, mining, and airport (on airport tarmacs) industries. *Id.* at 29:30–38.

The CAS 300 includes four main components types of (1) transponder sensor modules (TSMs) 306, 308, (2) control electronics modules (CEMs) 310, 312, (3) user interface modules (UIMs) 314, 316, and (4) central tracking unit (CTU) 318. Ex. 1001, 6:1–6. When a group of modules such as TSM 306, CEM 310, and UIM 314 are located in or on a single vehicle 302, they are referred to collectively as a vehicle mounted module (VMM) even though individual modules and components may or may not be housed in a unitary package or enclosure. *Id.* at 6:6–13, Fig. 3.

Figure 3 of the '227 patent is reproduced below to illustrate CAS 300 in which CTU 318 is configured in discrete housing 320 to receive location, speed, and separation distance from VMMs on vehicles 302, 304.

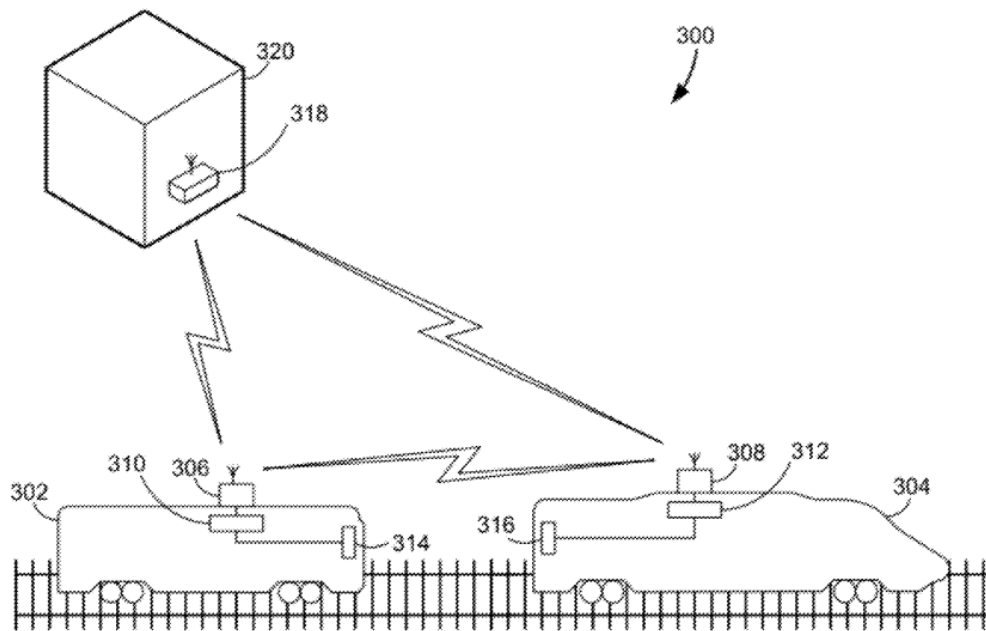


Fig. 3

Figure 3 depicts CTU 318 receiving data from VMMs (TSM 306/308, CEM 310/312, UIM 314/316) on rail vehicles 302, 304. Ex. 1001, 5:64–6:51. CTUs may be dispersed in VMMs as in Figure 4, reproduced below.

Fig. 4

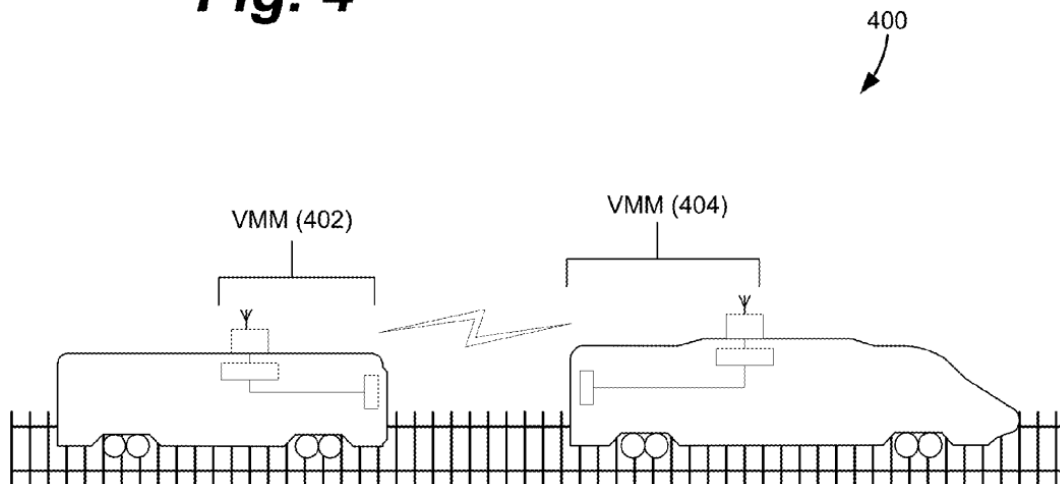


Figure 4 depicts CTUs dispersed in VMMs 402, 404 of each vehicle to track the location of other vehicles in a work gang. Ex. 1001, 6:52–7:3.

Figure 6 is reproduced below to depict a configuration of a VMM.

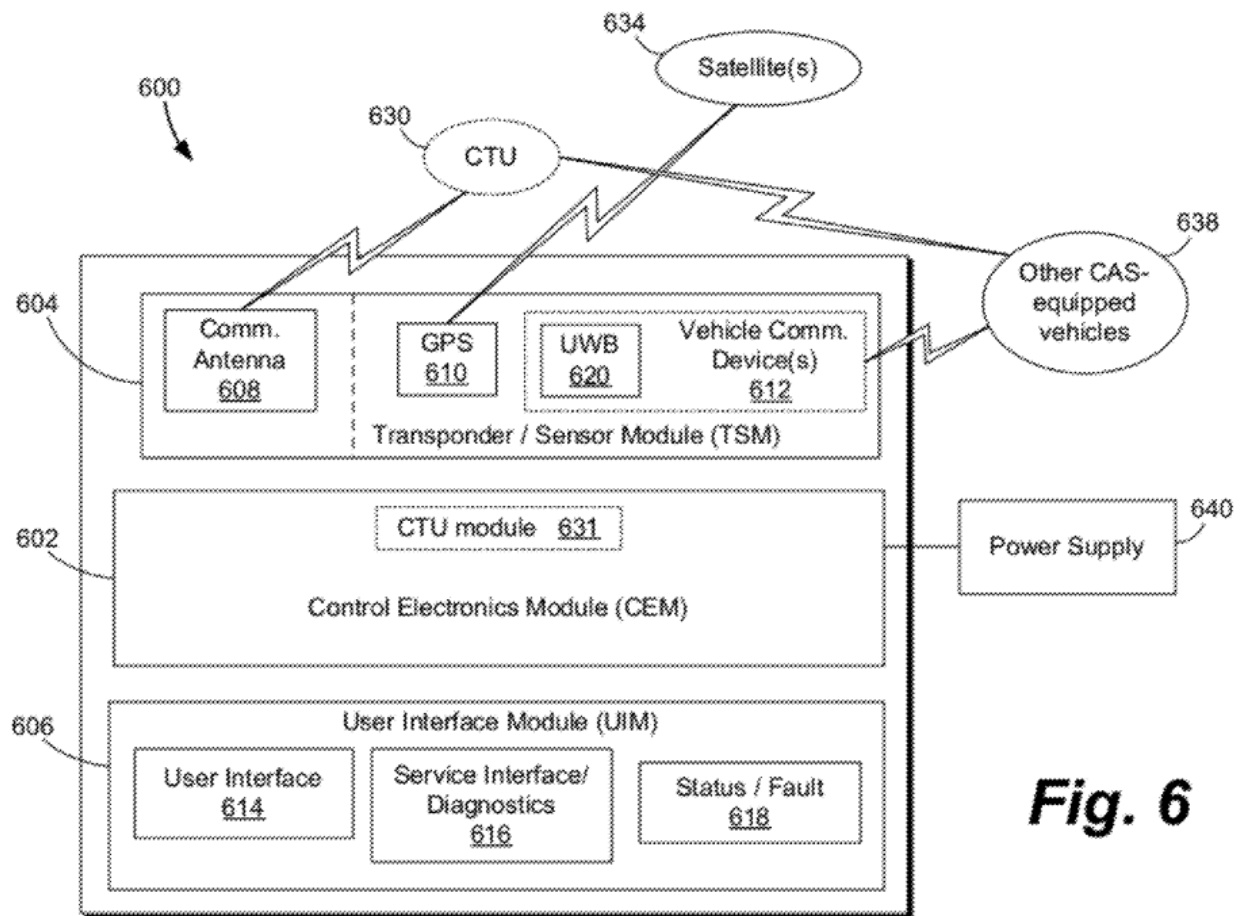


Fig. 6

Figure 6 is a block diagram of VMM 600 with CEM 602, TSM 604 and UIM 606. Ex. 1001, 7:28–45. TSM 604 includes wireless antenna 608 to send and receive data, GPS unit 610, and ultra-wideband (UWB) unit 620. *Id.* at 7:33–39. VMM 600 may transmit absolute position, relative position, and vehicle speed obtained from GPS unit 610, UWB unit 620, and/or other sensors to CTUs 631/630. *Id.* at 7:58–63. VMM 600 may gather absolute position data from satellites 634 using GPS unit 610. *Id.* at 7:66–8:2. User interface 614 may be located in a crew area/passenger cab. *Id.* at 8:46–47.

CEM 700 may use inertial measurement unit 710 with accelerometers and gyroscopes to detect changes in vehicle speed. *Id.* at 9:55–67, Fig. 7.

D. Challenged Claims

Petitioner challenges claims 1–28 of the '227 patent. Pet. 1–4. Claims 1, 17, and 24 are independent. Claims 2–16 depend from claim 1. Claims 18–23 depend from claim 17. Claims 25–28 depend from claim 24. Ex. 1001, 30:40–34:25 (the '227 patent claims).

Claim 1 is reproduced below reformatted from the '227 patent with Petitioner's annotations added to identify each limitation.

- [1-Pre] A collision avoidance system comprising:
 - [1A] one or more vehicle mounted modules, each vehicle mounted module mountable on a rail vehicle, each vehicle mounted module comprising:
 - [1B] a transponder sensor module operable to send and receive data wirelessly, the transponder module comprising a first ultra wideband unit and a first antenna;
 - [1C] a control electronics module comprising a processor in communication with at least the transponder sensor module unit; and
 - [1D] a user interface module including a user interface, the user interface being operable to provide rail vehicle information to a vehicle operator and to receive input from the vehicle operator; and
 - [1E] wherein each vehicle mounted module is operable to communicate with at least one other vehicle mounted module mounted on at least one other rail vehicle, and
 - [1F] wherein each vehicle mounted module is operable to apply a time of flight technique to determine a separation distance between the rail vehicles.

Ex. 1001, 30:40–59; *see* Pet. 84.¹

¹ We adopt and apply below in our analysis Petitioner's designations for the elements of the challenged claims. *See* Pet. 9–77, 84–89 (APPENDIX OF THE CHALLENGED CLAIMS).

E. Asserted Grounds of Unpatentability

Petitioner asserts that the challenged claims are unpatentable on the following seventeen grounds (Pet. 2–5):

Ground	Challenged Claim(s)	35 U.S.C. §	Reference(s)
1A	1, 11, 14	103(a) ²	Grisham ³
1B	2–4	103(a)	Grisham, Douglas ⁴
1C	5, 6	103(a)	Grisham, Richardson ⁵
1D	12, 13	103(a)	Grisham, Breed ⁶
1E	15	103(a)	Grisham, Connell ⁷
2A	7–9, 17–19, 21, 24–26	103(a)	Grisham, Nixon ⁸

² The Leahy-Smith America Invents Act (“AIA”) included revisions to 35 U.S.C. § 103 that became effective on March 16, 2013. Pub. L. No. 112-29, §§ 3(b)–3(c), 3(n)(1), 125 Stat. 284, 285–87 (2011) took effect on September 16, 2011. Changes made to 35 U.S.C. § 103 in the AIA do not apply to any application for patent filed before March 16, 2013. Because the ’227 patent has an effective filing date before March 16, 2013, we refer to the pre-AIA versions of § 103.

³ US 6,759,948 B2, issued July 6, 2004 (Ex. 1006, “Grisham”).

⁴ US 8,874,359 B2, issued Oct. 28, 2014 (Ex. 1011, “Douglas”).

⁵ Richardson, P., *An outdoor UWB tracking system to improve safety of semi-autonomous vehicle operations*, 1 INT. J. ULTRA WIDEBAND COMMUNICATIONS AND SYSTEMS 3:209–221, 2010 (Ex. 1008, “Richardson”).

⁶ US 2010/0052945 A1, published Mar. 4, 2010 (Ex. 1014, “Breed”).

⁷ US 2009/0255329 A1, published Oct. 15, 2009 (Ex. 1012, “Connell”).

⁸ WO 03/009254 A1, published Jan. 30, 2003 (Ex. 1016, “Nixon”).

2B	20	103(a)	Grisham, Nixon, Richardson
2C	22, 27, 28	103(a)	Grisham, Nixon, Douglas
2D	10	103(a)	Grisham, Nixon, McDaniel ⁹
2E	16	103(a)	Grisham, Nixon, McDaniel, Connell
2F	23	103(a)	Grisham, Nixon, McDaniel, Connell, Breed
3A	1, 7, 8, 11–14, 17–19, 24, 25	103(a)	Suzuki ¹⁰ or (Suzuki, Grisham)
3B	2–6, 20, 22, 27, 28	103(a)	(Suzuki, Richardson) or (Suzuki, Grisham, Richardson)
3C	9, 21, 26	103(a)	(Suzuki, Nixon) or (Suzuki, Grisham, Nixon)
3D	15	103(a)	(Suzuki, Connell) or (Suzuki, Grisham, Connell)
3E	10	103(a)	(Suzuki, Nixon, McDaniel) or (Suzuki, Grisham, Nixon, McDaniel)
3F	16, 23	103(a)	(Suzuki, Nixon, McDaniel, Connell) or (Suzuki, Grisham, Nixon, McDaniel, Connell)

Petitioner relies on a Declaration of Mr. Scott Andrews. Ex. 1003.
Patent Owner does not provide a declaration in support of its contentions.

⁹ US 2007/0255498 A1, published Nov. 1, 2007 (Ex. 1015, “McDaniel”).

¹⁰ EP 1 785 744 A1, published May 16, 2007 (Ex. 1005, “Suzuki”).

II. DISCUSSION

A. Level of Ordinary Skill in the Art

Petitioner asserts that a person of ordinary skill in the art “would have had a background in wireless electronics, including at least a bachelor’s degree in electrical engineering or a related field, and would have at least two years of experience with using such electronics for control systems applications such as collision-avoidance systems or positioning systems.” Pet. 7 (citing Ex. 1003 ¶¶ 23–28).

Patent Owner contends that Petitioner’s definition of a person of ordinary skill in the art (“POSITA”) should reflect that positioning systems are for rail-line vehicles and railway systems (Prelim. Resp. 3–5) as follows:

POSITAs would have had a background in wireless electronics, including at least a bachelor’s degree in electrical engineering or a related field, and would have at least two years of experience with using such electronics for control systems applications such as railway collision-avoidance systems or railway positioning systems.

Prelim. Resp. 5.

The ’227 patent provides some guidance on this issue. Specifically, the ’227 patent explains to the skilled artisan that

Although the present disclosure describes a collision avoidance system that may be applied to a work gang of railroad vehicles, the technology and the concepts described herein may be utilized in other vehicles, applications and/or industries, for example, in industries where spacing, location and status is important. Some industries that may utilize the concepts described herein are (1) the construction industry, (2) the mining industry, (3) the airport industry, specifically on airport tarmacs.

Ex. 1001, 29:30–38.

This disclosure indicates the '227 patent's CAS technologies can be used with other vehicles and systems. This technology uses UWB and GPS sensors to determine vehicle location, speed, and separation distance for collision avoidance as discussed above. Ex. 1001, 3:27–4:55, 5:64–8:8.

Other than the fact that vehicle mounted modules are mounted on “a rail vehicle,” separation distances are determined by time of flight technique with a UWB unit (claim 1) or GPS (claims 17 and 24), a CTU tracks VMMs (claims 2–4, 22, 27, 28), a VMM has an auxiliary transponder sensor module and auxiliary antenna (claims 5, 6, 20), VMMs use GPS and UWB units that receive information (claims 7, 8, 18, 19, 21, 25) to determine whether to issue warning signals (claims 9, 16, 26) with different thresholds (claims 10, 16), modules (claim 11), inertial measurement units (IMUs) (claims 12, 13, 23), and center frequencies (claim 14, 19). Ex. 1001, 30:40–34:25 (claims).

The claimed CAS and features measure distances between objects that are “rail vehicles” and issue warnings without claiming any implementation that is particular to railroad technologies, practices, or problems.

The asserted prior art indicates vehicle and train collision avoidance systems both use radio and GPS sensor technologies to determine locations, speeds, and separation distances to avoid collisions by warning operators. Ex. 1005 ¶¶ 13–34 (GPS for position determination; pulsed radar for separation distance and warning if less than a predetermined distance), 55–63 (using UWB to manage a car platoon); Ex. 1006, 18:53–24:29 (using impulse radio units as transceivers on rail vehicles, trains, railroad poles, and vehicles to measure separation distances and warn operators), Figs. 11–22; Ex. 1016, 3–8 (using UWB and GPS sensors to warn vehicle operators of nearby trains, airplanes, boats, ships, snowmobiles, and ATVs).

The '227 patent discloses that known CASs for trains rely on GPS.

Previous systems for preventing collisions of rail line vehicles have typically utilized a single sensor, for example a GPS or radar-based sensor, to monitor the approximate location of rail mounted vehicles [but] [a] shortcoming of single sensor systems, such as ones that depend on GPS sensors, is that the rail vehicles being monitored often enter into “blackout” areas (for example, around buildings, in the mountains, canyons, around sharp curves or in tunnels) where the single sensor may be unable to accurately determine the vehicle’s location.

Ex. 1001, 2:56–66. The problem of GPS blackout areas affects railroad, automotive, and other vehicles that traverse such areas.

Garcia¹¹ is cited to distinguish car and train CASs. Prelim. Resp. 5. Garcia states that Car-2-Car systems use GPS with *multihop networks* that may not work on railways that lack sufficient traffic to support multihops. Ex. 2001, 4. Yet, multihop networks are not claimed in the '227 patent.

The '227 patent describes “a rail vehicle” including *hyrail trucks* that travel on roads and tracks. See Ex. 1001, 3:43–60, Figs. 1C, 2 (vehicle 204). *Specific spacing* must “be maintained between vehicles when traveling to/ from work sites and when working at a work site.” *Id.* at 1:38–52; see *id.* at 3:43–60, Fig. 2; Ex. 1003 ¶ 233; Ex. 1012, 209–210; Ex. 1005, Figs. 1A, 17.

For purposes of our decision, we adopt Petitioner’s proposed level of skill in the art. See *Best Med. Int’l, Inc. v. Elekta Inc.*, 46 F.4th 1346, 1353 (Fed. Cir. 2022) (listing factors to assess the level of skill in the art as types of prior art problems and solutions, sophistication of technology, speed of innovations, and education level of the inventor and workers in the field).

¹¹ Garcia, C., *Comparison of Collision Avoidance Systems and Applicability to Rail Transport*, 10.1109/ITST.2007.4295927, July 2007 (Ex. 2001).

B. Qualifications of Mr. Andrews

Patent Owner also argues that “Mr. Andrews has no experience in collision avoidance systems for rail-line vehicles” and therefore “cannot appreciate the *differences* between collision avoidance systems for railway systems, *i.e.*, the ’227 patent, and roadway systems.” Prelim. Resp. 5, 6. Patent Owner asserts that Mr. Andrews is not a skilled artisan, and his “opinions should be discounted and accorded no weight.” *Id.* at 6.

As discussed above, the ’227 patent itself indicates that its collision avoidance system, which is configured for trains *and hyrail* vehicles, can be applied in other industries, vehicles, and applications to control vehicles. Ex. 1001, 29:30–38 (mining, construction, airports). This disclosure is consistent with the prior art’s use of such technologies for trains, vehicles, trucks, planes, boats, ships, snowmobiles, and ATVs. Ex. 1016, 6; Ex. 1001, 3:43–60, Figs. 1C (hyrail vehicle), 2 (vehicle 204); Ex. 1005 ¶¶ 2–9, 55–59; Ex. 1006, 18:53–24:28, Figs. 9–22; Ex. 1008, Abstract, 209–213, Figs. 1–7.

Mr. Andrews’ more than twenty years of experience with wireless technologies and transportation collision avoidance systems qualifies him as more than a person of ordinary skill in the art by both parties’ definitions, and Mr. Andrews’ supervision of skilled artisans has familiarized him with their level of skill. Ex. 1003 ¶ 28. Any lack of railway experience affects the weight we may give to his testimony. As discussed below, his testimony is consistent with the asserted prior art and the ’227 patent. As claimed, the CAS technology is simple enough that expert testimony is helpful, but not essential, to our understanding of the references and issues. *See Wyers v. Master Lock Co.*, 616 F.3d 1231, 1242 (Fed. Cir. 2010); *Perfect Web Techs., Inc. v. InfoUSA, Inc.*, 587 F.3d 1324, 1329 (Fed. Cir. 2009).

C. Claim Interpretation

We interpret claims using the same claim construction standard that would be used to construe the claims in a civil action held under 35 U.S.C. 282(b).” 37 C.F.R. § 42.100(b). Under this standard, we construe claims “in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” *Id.* We construe the claims only to the extent necessary to determine whether to institute *inter partes* review. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (“[W]e need only construe terms ‘that are in controversy, and only to the extent necessary to resolve the controversy.’”) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

Petitioner asserts that no express claim constructions are needed for this proceeding. Pet. 8. Patent Owner does not propose claim constructions for any terms but reserves “its right to propose constructions for one or more claim terms at a later time.” Prelim. Resp. 3.

D. Prosecution History of the ’227 patent

The Examiner determined that the closest prior art of record (Rubin, US 2013/0279392) disclosed a transceiver and a *vehicle-2-vehicle* safety and communication system to broadcast vehicle location, heading, and speed but did not teach or suggest a vehicle mounted module operable to communicate with another vehicle mounted module mounted on another vehicle to apply a time of flight technique to determine a separation distance between the rail vehicles or use a GPS unit to determine if vehicle separation criteria are violated and generate a warning signal if vehicle separation criteria are violated. Ex. 1002, 329–330 (Allowable Subject Matter).

E. Principles of Law

A patent claim is unpatentable under 35 U.S.C. § 103 if differences between the claimed subject matter 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 to which said subject matter pertains. 35 U.S.C. § 103; *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). “The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.” *KSR*, 550 U.S. at 416. Similarly, “if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.” *Id.* at 417.

The question of obviousness is resolved based on underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) when in evidence, objective evidence of non-obviousness. *Graham v. John Deere Co. of Kan. City*, 383 U.S. 1, 17–18 (1966). Neither party submits evidence of secondary considerations.

F. Ground 1A: Alleged Obviousness Over Grisham

Petitioner asserts that claims 1, 11, and 14 are unpatentable under § 103(a) over Grisham. Pet. 1, 2, 9–17.

1. Grisham (Ex. 1006)

Grisham’s system warns people of nearby locomotives. Ex. 1006, 1:16–19, 2:27–31. Figure 13 is reproduced below to depict such a system.

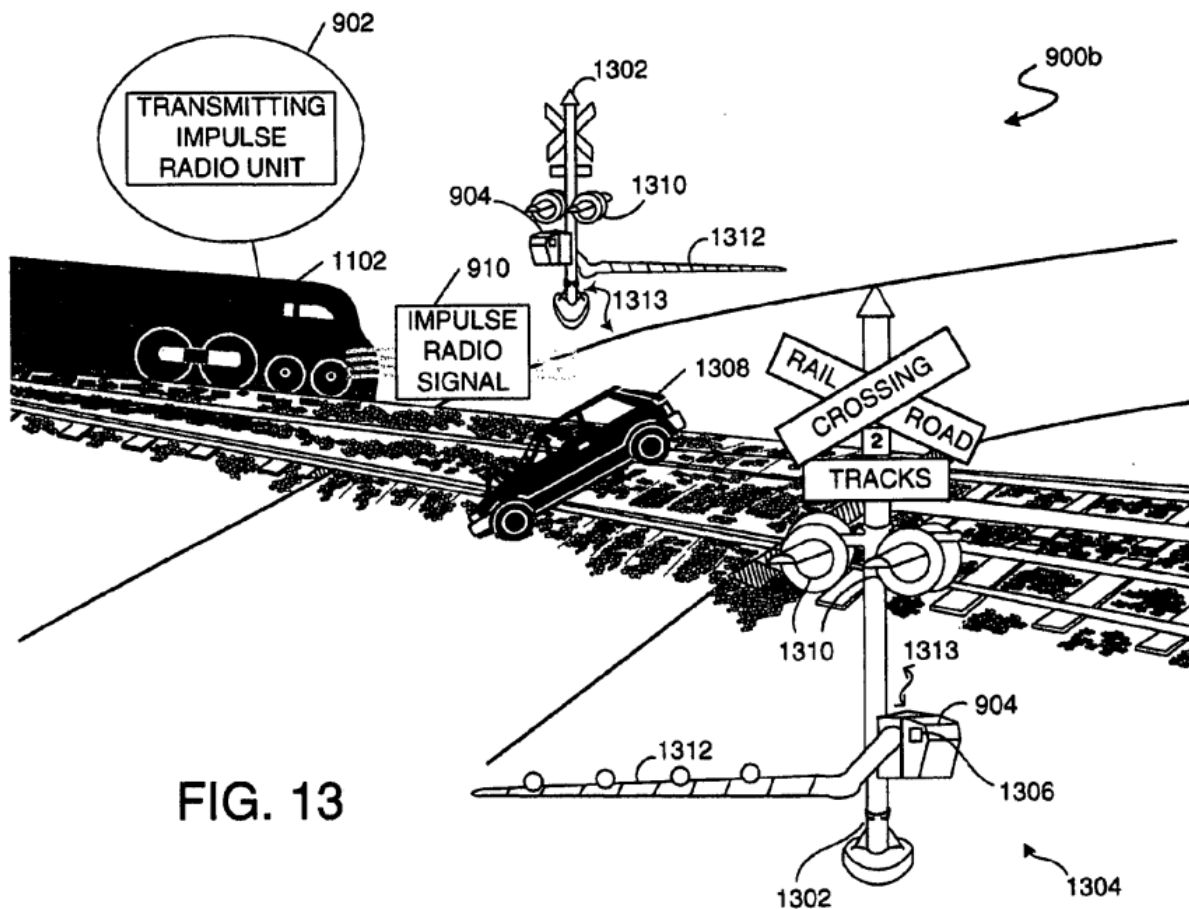


FIG. 13

Figure 13 of Grisham depicts warning system 900b with transmitting impulse radio unit 902 coupled to locomotive 1102 to send radio signals 910 to receive impulse radio unit 904 coupled to railroad pole 1302 and interact with controller 1306 to activate warning light 1310 or gate 1312 to warn vehicle 1308 of locomotive 1102 near crossing 1304. Ex. 1006, 21:15–45.

2. Independent Claim 1

Regarding element [1-Pre], Petitioner contends that Grisham discloses a railroad collision avoidance system for preventing train accidents. Pet. 10 (citing Ex. 1006, title, 2:16–31, 24:46; Ex. 1003 ¶¶ 103–105). This contention, which Patent Owner does not contest at this stage, is supported sufficiently by evidence of record.

Grisham's field of invention is "a railroad collision avoidance system and method for preventing train accidents." Ex. 1006, 1:8–10; *id.* at 2:16–19 (the invention is a railroad collision avoidance system that warns people when a locomotive is in their vicinity).

Regarding element [1A], Petitioner contends that Grisham discloses modules (radio units 902, 904) mounted on locomotives (rail vehicles) and the units include the components recited in elements [1B]–[1D] that form a "vehicle mounted module" as claimed. Pet. 11–12 (citing Ex. 1006, 23:33–40, Figs. 21, 22; Ex. 1003 ¶¶ 106–118). This contention, which Patent Owner does not contest at this stage, is supported sufficiently by evidence of record. Grisham's collision avoidance system 900 couples transmitting impulse radio unit 902 to locomotives 1102, 2102 to transmit impulse radio signal 910 to receiving impulse radio unit 904 on locomotive 1102, 2102 to alert operators of each locomotive of the presence and speed of the other locomotive. Ex. 1006, 23:33–24:28, Figs. 21, 22.

Regarding element [1B], Petitioner asserts that Grisham discloses that transmitting impulse radio unit 902 and receiving impulse radio unit 904 send and receive signals wirelessly and may be combined into a transceiver impulse radio unit that sends and receives data wirelessly as "a transponder sensor module." Pet. 12 (citing Ex. 1006, 16:39–49, 16:59–60, 17:44–46, Figs. 6, 7). Petitioner asserts that Grisham's "impulse radio" is an "ultra-wideband system" that emits wide-band and ultrawide-band signals using an "ultra-wideband" antenna, and skilled artisans would understand Grisham's impulse radio transceiver and antenna are a "first ultra-wideband unit," "first antenna," and "transponder" as claimed. Pet. 13 (citing Ex. 1006, 4:44–53, 6:12, 6:36–43, 16:39–49, 16:59–60, 17:44–46; Ex. 1003 ¶¶ 108–111).

Patent Owner argues that Petitioner mischaracterizes Grisham, which discloses radio unit 902 on rail vehicle 1102 as a “transmitting impulse radio unit” that is operable to send an impulse radio signal wirelessly rather than send and receive data wirelessly as claimed. Prelim. Resp. 11–12. Patent Owner argues that radio unit 904 on rail vehicle 2102 is merely a “receiving impulse radio unit” that is operable only to receive an impulse radio signal wirelessly and cannot send *and* receive data wirelessly as claimed. *Id.* at 12.

Patent Owner also argues that Grisham does not teach or suggest that transmitting impulse radio unit 902 and receiving impulse radio unit 904 are or can be combined into a single module to send and receive wireless data as the Petition alleges, and the Petition offers no motivation to combine the two radio units into a single module, no support from Mr. Andrews, its expert, and no showing of a reasonable expectation of success. *Id.* at 12–13.

Grisham describes an “Exemplary Transceiver Implementation” that comprises a “Transmitter” *and* a “Receiver.” Ex. 1006, 16:14–17:43. “In a *transceiver embodiment*, substantial economy can be achieved by sharing part or all of several of the functions of the transmitter 602 and receiver 702” and shared functions include “time base 718, precision timing generator 714, code source 722, [and] *antenna 704*.” *Id.* at 17:44–48 (emphasis added).

No motivation is needed to combine transmitter 602 and receiver 702 to form a transceiver because Grisham teaches a *transceiver embodiment* as Petitioner asserts. Ex. 1006, 16:14–48, Figs. 6, 7; Pet. 12 (citing Ex. 1006, 17:44–46; Ex. 1003 ¶ 109 (same)). Figure 21 mounts transmitting impulse radio unit 902 and receiving impulse radio unit 904 on each locomotive 1102, 2102 to function as transceivers that send and receive radio signals. *See* Ex. 1006, 23:33–24:29, 16:14–17:48.

Grisham describes mounting transmitting impulse radio unit 902 on locomotive 1102 to transmit impulse radio signal 910 to receiving impulse radio unit 904 on locomotive 2102 (Ex. 1006, 23:33–63) and states that “[i]t should be understood that the first locomotive 1102 can contain the same equipment as the second locomotive 2102 . . . and as such could be notified of the presence and speed of an oncoming second locomotive 2102” (*id.* at 24:24–29). Each locomotive 1102, 2102 has transmitting *and* receiving impulse radio units that function as transceivers to send and receive data as impulse radio signals 910 to notify operators on each locomotive of the presence and speed of the other locomotive to achieve substantial economy.

Mr. Andrews testifies that Grisham combines transmitter 602 and receiver 702 into transceiver units that transmit and receive as a transponder. Ex. 1003 ¶¶ 108–111 (embodiments transmit and receive as transceivers).

Regarding element [1C], Petitioner asserts that Grisham discloses “a control electronics module” as controller 1110 that is part of transponder sensor module of element [1B], and skilled artisans would have understood that Grisham’s controller comprises a processor or would have been motivated to include one for processing data that it receives, and controller 1110 (and its processor) communicate with receiving impulse unit 904 in each transponder sensor module to communicate with other radio units via impulse radio signal 910. Pet. 13 (citing Ex. 1006, 23:64–24:24, Fig. 22; Ex. 1003 ¶¶ 112–115). This contention, which Patent Owner does not contest at this stage, is supported sufficiently by evidence of record. Receiving impulse unit 904 and controller 1110 in each transponder sensor module receive impulse radio signals 910 that controller 1110 processes to measure distances between locomotives 1102, 2102. Ex. 1006, 23:66–24:8.

Regarding element [1D], Petitioner contends that Grisham's receiving impulse unit 904 may be incorporated within, or coupled to, an after-market display 1108a or an in-dash display, which provides a user interface module that displays direction, distance, and speed of an oncoming train to a vehicle operator *and* receives communications from a train operator to communicate with operators on another train. Pet. 14 (citing Ex. 1006, 23:52–66, Fig. 21; Ex. 1003 ¶¶ 116–118).

Patent Owner argues that Grisham discloses an after-market display or an in-dash display, and the Petition does not contend that either is operable “to receive input from the vehicle operator” as claimed. Prelim. Resp. 13. Patent Owner argues that the Petitioner asserts a skilled artisan would have understood it was conventional for displays including aftermarket displays to receive user input such as adjustments to the display's settings and cites its expert, Mr. Andrews, who repeats this conclusory assertion without citing any additional supporting evidence or technical reasoning. *Id.* at 13–14.

Petitioner has provided sufficient evidence that Grisham's receiving impulse radio unit 904 includes a user interface module and after-market or in-dash display 1108a, 1108b that alerts operators of locomotive 1102/2102 of the presence of an approaching locomotive 2102/1102 with the direction, distance, and/or speed of the locomotive. Ex. 1006, 23:33–24:29; *see* Pet. 14 (citing Ex. 1006, 23:52–56, 23:57–66, Fig. 21); Ex. 1003 ¶ 117 (quoting Ex. 1006, 23:52–56 and its description of displays 1108a, 1108b that show direction, distance, and/or speed of an oncoming locomotive 1102).

Display 1108 also receives input from an operator to communicate with a person on another locomotive via impulse radio signals. Ex. 1006, 19:51–54, 23:1–4, 23:60–63 (cited in Pet. 14 and Ex. 1003 ¶ 117).

Patent Owner does not dispute that Grisham’s display receives input of operators who communicate with operators on other trains. Prelim. Resp. 13–14; Pet. 14; Ex. 1003 ¶ 117. The ’227 patent describes user interfaces that allow operators to send messages to other vehicles. Ex. 1001, 18:46–56.

Mr. Andrews testifies that such “after-market” displays are known to receive user input to adjust display settings. Ex. 1003 ¶ 118. Mr. Andrews supports his opinion with Grisham’s disclosure that after-market displays allow operators to communicate with operators of other vehicles so the user interface receives user inputs. *Id.* ¶¶ 117 (citing Ex. 1006, 23:52–66), 118.

Regarding element [1E], Petitioner asserts that impulse radio unit 902 continually transmits an impulse radio (UWB) signal to impulse radio unit 904 on another train. Pet. 14–15 (citing elements [1A] and [1B]; Ex. 1006, 22:45–49, 23:36–49, 24:25–29, Figs. 19, 21; Ex. 1003 ¶¶ 119–121). These contentions, which Patent Owner does not contest, are supported sufficiently by evidence of record. Impulse transceivers on different trains communicate with one another. Ex. 1006, 16:14–17:48, 23:33–24:29, Figs. 21, 22.

Regarding element [1F], Petitioner contends that Grisham’s radio-unit controllers use time position measurements to measure a propagation delay and determine a link distance between impulse radio units and locomotives, and the time of flight (TOF) technique incorporates Richards (US 6,133,876, Ex. 1013) and its pulse sequences between two transceivers to measure total TOF difference using two signal pulses. Pet. 16 (citing Ex. 1006, 24:18–24, 14:56–62, Figs. 21, 22; Ex. 1013, 2:31–46; Ex. 1003 ¶¶ 122–124). This contention, which Patent Owner does not contest, is supported sufficiently by evidence of record. On this record, we find Petitioner has established a reasonable likelihood that claim 1 is unpatentable over Grisham.

3. *Claims 11 and 14*

Regarding claims 11 and 14, Petitioner asserts that Grisham discloses vehicle-mounted radio units with controllers and ultra-wideband units that communicate with each other to determine the speed of a rail vehicle based on measurements by the ultra-wideband units (claim 11) and the radio units use “a desired center frequency” by altering the waveform significantly for a given application, which skilled artisans would understand to mean the radio units are designed to transmit and receive ultrawide-band signals of varying center frequencies (claim 14). Pet. 16–17 (citing discussion for elements [1B], [1C], and [1E] in Ground 1A; Ex. 1006, 4:61–5:12, 18:60–19:4, 23:64–24:24; Ex. 1003 ¶¶ 125–131).

Patent Owner argues that the Petition does not show that Grisham discloses a first ground speed detection module in claim 11. Prelim. Resp. 14–15. Yet, Grisham’s CAS provides communications between transmitting impulse radio unit 902 and receiving impulse radio unit 904, either of which may be coupled to a locomotive, *a control box* by the tracks, *a railroad pole*, (with zero velocity), a vehicle, or another locomotive as Petitioner asserts. Ex. 1006, 18:58–9:4 (cited in Pet. 16–17). Impulse radio signals 910 are received by impulse radio unit 904 and processed to determine the link distance between unit 904 and the approaching locomotive 1102 and the distances are updated so the speed of locomotive 1102 can be determined by controller 1110 and displayed along with its distance and direction. *Id.* at 23:64–24:24 (cited in Pet. 17 and Ex. 1003 ¶ 126). Ground speed detection modules 904 in railroad poles 1302 and control boxes 1502 determine and update distances of approaching locomotives to calculate speeds. Ex. 1006, 18:58–20:14, 20:15–21:58, 23:5–24:36, Figs. 9, 13, 17, 21, 22.

Patent Owner attacks Petitioner's contentions for claim 14 as being just two sentences with a citation to Mr. Andrews' Declaration, whose analysis of the prior art is not reflected in the Petition. Prelim. Resp. 15–16.

Grisham's UWB units use an impulse radio waveform that "attempts to approach one cycle of radio frequency (RF) energy *at a desired center frequency*" and "this waveform may be altered significantly in practice for a given application." Ex. 1006, 4:61–5:12 (emphasis added) (cited in Pet. 17 and Ex. 1003 ¶ 129). Altering waveforms for a given application to be one cycle of RF energy at a desired center frequency varies the center frequency of the waveform. Ex. 1006, 4:61–5:2 (cited in Pet. 17 and Ex. 1003 ¶ 129).

Patent Owner argues that the '227 patent describes varying center frequencies as transmitting "multiple pulses/signals with different center frequencies at different times" (Prelim. Resp. 16 (citing Ex. 1001, 16:18–20)) whereas in Grisham "the center frequency is set at calibration to the desired center frequency" (*id.* (citing Ex. 1006, 16:25–26)). Yet, claim 14 only requires an ultra wideband unit "adapted to transmit and receive signals with varying center frequencies." Ex. 1001, 31:63–65. Patent Owner admits that Grisham's UWB unit is adapted to transmit and receive signals with varying center frequencies by calibrating it with a desired center frequency. Grisham also alters impulse radio waveforms "significantly in practice for a given application" to approach one cycle of RF energy at a desired center frequency as discussed. Ex. 1006, 4:61–5:12; *id.* at 5:1–2 ("waveforms having very broad, or wide, spectral bandwidth approximate a Gaussian shape to a useful degree."); *see id.* 5:60–6:35, 7:50–57, Figs. 1A–1F.

On this record, we find that Petitioner has established a reasonable likelihood that claims 11 and 14 are unpatentable over Grisham.

G. Ground 1B: Obviousness Over Grisham and Douglas

Petitioner asserts the unpatentability of claims 2–4 under § 103(a) over Grisham and Douglas. *See* Pet. 2, 17–20.

1. Douglas (Ex. 1011)

Douglas’ collision avoidance system equips trains with apparatus 20 (transceiver and processor) to enable them to communicate with each other over a wireless network and with apparatus 32 at station 30. Ex. 1011, 1:9–10, 3:1–30. Each train broadcasts a signal with a unique identification of the train and the track on which the train is moving using the transceivers so a receiving apparatus 20 can identify the train transmitting the signal with its direction of motion and respective track. *Id.* at 3:30–47, Figs. 1, 1b.

2. Claims 2–4

Regarding claim 2, Petitioner asserts that Douglas locates apparatus 32 at train station 30 to receive information transmitted by trains such as the track a train is moving on and broadcasts locations of trains within a certain range via a list of links to be traversed by each train and the direction of motion and path of each train. Pet. 18. Petitioner asserts that skilled artisans would understand that the station-based apparatus tracks the location of the trains by repeatedly updating the trains’ paths. *Id.* Petitioner asserts that skilled artisans would have been motivated to combine Douglas’ apparatus with Grisham’s train-to-train embodiment to use existing railway and train-control infrastructure to identify conflicts between paths of trains and potential collisions before trains enter the range where Grisham’s train-to-train communication is effective. *Id.* at 18–19 (citing Ex. 1011, 3:18–23, 3:31–47, 4:23–49, 7:10–12; Ex. 1003 ¶¶ 132–136).

Patent Owner argues that the Petition appears to recognize that neither Grisham nor Douglas expressly discloses a central tracking unit that tracks locations of a vehicle mounted module by asserting that skilled artisans would understand that Douglas' station-based apparatus tracks the locations of trains by repeatedly updating the trains' paths via a list of links to travel and the direction of travel of each train on a track. Prelim. Resp. 19. Patent Owner asserts that neither the Petition nor Mr. Andrews explains why this is so or provides any additional supporting evidence. *Id.* Patent Owner further argues that the Petition fails to address the reasonable expectation of success in combining Grisham's embodiment with Douglas' system so a location of the first and second vehicle mounted modules can be tracked based on a list of links and direction of motion and paths of trains. *Id.* at 19–20.

The '227 patent describes central tracking unit (CTU) 318 accepting information from vehicle mounted modules (VMMs) in vehicles of a work gang such as location, speed, and separation distance. “[T]he CTU may analyze absolute and relative positioning data and speed data from vehicles in the work gang.” Ex. 1001, 6:19–32. No technical implementation details are provided. *See id.* at 4:22–26, 5:41–52, 6:19–7:3; 28:13–17, Fig. 3.

Douglas describes apparatus 32 located at station 30 communicating with apparatuses 20 located on trains to receive information over a wireless network from trains 12–18 (Ex. 1011, 3:18–30) including identification of each train, identification of the track on which each train is moving, and a direction of motion of each train (*id.* at 3:30–47) and process this data to provide each train with a list of rail links and tracks each train will travel, the direction of movement of each train, and other trains that are *located in* the zone of station 30 (*id.* at 4:32–53, 7:10–12). *See* Pet. 18 (citations therein).

Douglas thus tracks the locations of trains along specific tracks 22–28 relative to links 23–27 that connect specific tracks to allow a specific train to switch tracks at a particular location and within the zone of station 30. This tracking of each train 12–18 and mounted apparatus 20 tracks its location as recited in claim 2. Petitioner and Mr. Andrews rely on teachings of Douglas that apparatuses 20 on each train broadcast their ID, track ID, and direction of motion location information so apparatus 32 at station 30 can broadcast a list of links that each train will traverse with a direction of motion and list of trains within a zone (location) of station 30. Ex. 1011, 3:1–4:60, 6:63–7:23, Fig. 1; Pet. 18 (and citations therein); Ex. 1003 ¶¶ 133–136.

“The reasonable expectation of success requirement refers to the likelihood of success in combining references to meet the limitations of the claimed invention.” *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367 (Fed. Cir. 2016) (“[F]ailure to consider the appropriate scope of the . . . patent’s *claimed invention* in evaluating the reasonable expectation of success . . . constitutes a legal error that [is] review[ed] without deference.”) (citation omitted). The expectation of success need only be reasonable rather than absolute. *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1364 (Fed. Cir. 2007) (“[C]ase law is clear that obviousness cannot be avoided simply by a showing of some degree of unpredictability in the art so long as there was a reasonable probability of success.”).

Here, the ’227 patent and Douglas evidence a level of predictability in the art to implement a CAS with a central tracking unit that communicates with first and second VMMs to track the locations of the VMMs. On this record, we find that Petitioner has established a reasonable likelihood that claim 2 is unpatentable over Grisham and Douglas.

Regarding claim 3 and 4, Petitioner contends that Douglas discloses an alternative embodiment in which a central tracking unit apparatus 20 on each train 12–18 may generate a state table of links for each train to travel between tracks and a direction of travel of each train on a track (claim 3) and the central tracking unit 32 at station 30 is in a discrete housing as shown in Figures 1 and 1b (claim 4). Pet. 19–20 (citing Ex. 1011, 3:1–30, 7:12–19; Ex. 1003 ¶¶ 137–141). These contentions, which Patent Owner does not contest at this stage, are supported sufficiently by evidence of record.

On this record, we find that Petitioner has established a reasonable likelihood that claims 3 and 4 are unpatentable over Grisham and Douglas.

H. Ground 1C: Alleged Obviousness Over Grisham and Richardson

Petitioner asserts the unpatentability of claims 5 and 6 under § 103(a) over Grisham and Richardson. *See* Pet. 2, 21–26.

1. Richardson (Ex. 1008)

Richardson describes a UWB positioning system that improves safety by positioning coordinate radios at each corner of a vehicle to provide more accurate position measurements between vehicles in a convoy. Ex. 1008, 209–210, 212–214, Figs. 1, 2, 6, 7. The system controller selects two radios to be requesters and two radios to be responders in order to minimize the dilution of precision (DOP) that can result based on the respective angles and orientations of both vehicles and the location of the positioning radios that are selected to measure position. *Id.* at 213 (configuring coordinate radio pairs to define eight zones), Fig. 6 (depicting eight zones for distance measurement), 7 (illustrating bilateration for position measurement).

2. *Claims 5 and 6*

Petitioner asserts that Richardson uses four UWB transceivers with an offset distance of r_b as “auxiliary transponder sensor module” and auxiliary antenna as recited in claims 5 and 6 to improve location measurements and collision avoidance. Pet. 22–26. Petitioner asserts that skilled artisans would have understood that Grisham’s ability to calculate distances using the location of impulse radio modules on lengthy trains would be inadequate to avoid collisions at other points on the train that may be a mile away so such artisans would have been motivated to supplement Grisham’s system with other vehicle proximity detection systems including Richardson’s use of multiple UWB transceivers to account for the length of a train to improve location measurements and avoid collisions including using Richardson’s user interface to calibrate ranging of the modules for a train. *Id.* at 23–26 (citing Ex. 1008, 211, 213, 214, Figs. 6, 7; Ex. 1003 ¶¶ 142–152).

Patent Owner argues that Petitioner fails to explain how Richardson’s system that improves navigation and safety for semi-autonomous systems could “account for the length of a train” of over a mile when Richardson’s system is designed for use between 2 and 40 meters. Prelim. Resp. 20–21. Patent Owner asserts that Petitioner’s motivation is conclusory and relies on Mr. Andrews’ Declaration that provides a series of unsupported conclusions that are entitled to little or no weight, and the Petition does not address whether a skilled artisan would have had a reasonable expectation of success in combining Grisham’s train-to-train communication system with Richardson’s system for semi-autonomous construction and agricultural vehicles. *Id.* at 22–24.

The '227 patent describes an embodiment in which a vehicle 900 uses multiple offset transponder sensor modules (TSMs) 902, 904 and a sensor included in TSM 904 is placed near the end of the vehicle to calibrate itself to determine the location of the vehicle's end and other vehicles. Ex. 1001, 12:2–8, Fig. 9. A vehicle operator can specify the vehicle's length from the mounted TSMs so the components can compute distances between mounting locations and the ends of the vehicle. *Id.* at 11:59–12:53. The system may calibrate for vehicle length and mounting locations. *Id.* at 12:28–31. TSMs may be mounted at a vehicle's front and rear ends. *Id.* at 12:36–38.

Richardson mounts four UWB radios on corners of each vehicle of a convoy to measure distances between adjacent vehicles by defining positions of adjacent vehicles. Ex. 1008, 212–213. “[T]he four coordinate radios are spaced so as to limit DOP [dilution of precision] and eight zones are defined using radio pairings as shown in Figure 6 to balance the effects of DOP between zones.” *Id.* at 213. “At each position update, the controller on the following truck selects two radios to be requesters and two radios to be responders based on minimization of DOP.” *Id.* The more accurate position measurements improve safety (and reduce collisions). *Id.* Abstract.

Petitioner proposes to apply this technique in Grisham for similar benefits of better measurements between a train (front and rear ends) and nearby vehicles to avoid collisions as Richardson teaches. Pet. 22–23; *see KSR*, 550 U.S. at 417; Ex. 1003 ¶¶ 145–146; Ex. 1008, 209–214. These teachings evidence a high degree of predictability in this art to support a reasonable expectation of success in the combination. On this record, we find that Petitioner has established a reasonable likelihood that claims 5 and 6 are unpatentable over Grisham and Richardson.

I. Ground 1D: Alleged Obviousness Over Grisham and Breed

Petitioner asserts the unpatentability of claims 12 and 13 under § 103(a) over Grisham and Breed. *See* Pet. 2, 27–29.

1. Breed (Ex. 1014)

Breed’s safety system uses an inertial measurement unit (IMU) with accelerometers and gyroscopes to measure acceleration and angular rate and changes thereto to improve location tracking and velocity measurements of vehicles to reduce a risk of collision. Ex. 1014 ¶¶ 13, 93, 109, 205, 567.

2. Claims 12 and 13

Regarding claims 12 and 13, Petitioner contends that Breed uses an IMU in a vehicle location system, and the IMU contains accelerometers that measure vehicle acceleration in latitude, longitude, and vertical directions and the changes in speed are sent to a processor. Pet. 27–29 (citing Ex. 1014 ¶¶ 93, 205, 225, 567; Ex. 1003 ¶¶ 153–161; Ex. 1006, 2:16–31, 24:46).

Petitioner contends that skilled artisans would have been motivated to consider speed and acceleration detection systems such as that of Breed to supplement Grisham’s UWB-based system to ensure position data and calculations regarding the potential for collision are as exact as possible by knowing a train’s location to avoid collisions. Pet. 28. Petitioner asserts that skilled artisans would have been motivated to modify Grisham in view of Breed to couple an IMU with its accelerometers and gyroscopes to provide accurate speed and acceleration data beyond the working range of UWB to assist in avoiding collisions by vehicle-to-vehicle communications as Grisham desires. *Id.* at 28–29 (citing Ex. 1006, 2:16–31, 24:46; Ex. 1003 ¶¶ 157–159).

Patent Owner argues that Breed does not disclose an IMU “operable to detect changes in the speed of the first rail vehicle” as recited in claim 12. Prelim. Resp. 24. Patent Owner asserts that none of the cited portions of Breed teach an IMU “operable to detect changes in the speed” of a train and Mr. Andrews’ declaration does not address this limitation. *Id.* at 24–25.

The ’227 patent discloses control electronics module (CEM) 700 with inertial measurement unit 710 with accelerometers and/or gyroscopes that is “operable to . . . detect *changes in the speed* of a traveling vehicle” such as sudden changes in speed that indicate a vehicle was involved in a collision. Ex. 1001, 9:55–59, 9:67–10:3. Microwave radars and laser devices may measure ground speed. *Id.* at 9:2–4, 20:15–21:6. The ’227 patent therefore distinguishes devices that measure *changes in speed* from devices that measure speed. Ex. 1001, 9:2–4, 9:55–10:3, 20:15–21:6, Fig. 7 (706, 710).

Breed discloses a vehicle-to-vehicle communication system with an IMU that includes accelerometers to provide a vehicle’s acceleration and gyroscopes to measure angular rates or velocities. Ex. 1014 ¶¶ 13, 93, 567.

Acceleration is “the rate of change of velocity with respect to time.” Merriam-Webster.com at “<http://www.merriam-webster.com/dictionary/acceleration>” (accessed May 12, 2023). Ex. 3001. By detecting vehicle acceleration, Breed’s IMU is “operable to detect changes in the speed of a . . . vehicle” as claimed and Breed’s system may be used with automobiles, trucks, *railroad cars*, ships, and airplanes. Ex. 1014 ¶ 88; *see* Ex. 1003 ¶ 156 (Breed teaches accelerometers that measure “vehicle acceleration in the latitude, longitude, and vertical directions”) (citing Ex. 1014 ¶ 567), ¶ 158 (skilled artisans understand “tracking changes in speed or acceleration is important for knowing a train’s location and avoiding collisions”).

Mr. Andrews testifies that using Breed's IMU with Grisham's UWB-based system would improve positioning and location determination by measuring vehicle speed independently and tracking changes in speed and acceleration to know a train's location, avoid collisions and obstacles, and fill gaps when satellites are out of view for train safety (by redundancy) and preventing collisions. Ex. 1003 ¶¶ 156–159. His testimony is supported by record evidence that communicating vehicle position and velocity data can reduce a risk of collision. Ex. 1014 ¶ 211 (dead reckoning fills gaps when satellites are out of view); Ex. 1006, 2:16–31; Ex. 1003 ¶ 159.

On this record, we find that Petitioner has established a reasonable likelihood that claims 12 and 13 are unpatentable over Grisham and Breed.

J. Ground 1E: Alleged Obviousness Over Grisham and Connell

Petitioner asserts the unpatentability of claim 15 under § 103(a) over Grisham and Connell. *See* Pet. 2, 29–30.

1. Connell (Ex. 1012)

Connell teaches a control system 20 that is operable to determine brake shoe effectiveness data 22 dynamically and use that data to provide sufficient information to determine the ability of a braking arrangement to retard a train to a specified level, whether a speed level or a complete stop, based on braking data and a brake database 12 and train data 18 and a train database 16. Ex. 1012 ¶ 26. Once the desired brake shoe effectiveness data 22 is determined, control and operational parameters of the train are determined or set such as speed limits, maximum speed limit, braking curve distance required for the train to stop completely, and stopping distance. *Id.* ¶ 28.

2. *Claim 15: Petitioner's contentions*

Petitioner asserts that Connell calibrates the distance required for a train TR to stop completely by dynamically determining the brake shoe effectiveness as the train travels and skilled artisans would understand this teaching to mean the distance between a first location when the brakes are engaged and a second location when the vehicle comes to a complete stop as claimed. Pet. 29–30 (citing Ex. 1012 ¶¶ 25, 26; Ex. 1003 ¶¶ 162–165).

Patent Owner argues that Grisham and Connell lack “the first vehicle mounted module [that] is operable to execute a stopping distance calibration feature that measures a stopping distance under existing conditions” as claimed. Prelim. Resp. 28–29. Patent Owner argues that Mr. Andrews does not support the Petitioner’s statement that Connell discloses “the distance required for the train TR to completely stop is calibrated by dynamically determining brake shoe effectiveness as the train travels” but testifies that a skilled artisan would have determined or calibrated appropriate stopping distances by physically testing the rail vehicles under different conditions and adopting the appropriate calibration under existing conditions. *Id.* at 29.

Mr. Andrews testifies that Connell has a vehicle mounted module that executes a stopping distance calibration feature that measures a stopping distance under existing conditions as control system 20 using brake database 12 and train database 16 to dynamically determine brake shoe effectiveness data 22 and the ability of the braking to retard the train to a specified level, e.g., a speed level *or a complete stop* and control operational parameters such as *a braking curve, which is the distance required for the train TR to completely stop*. Ex. 1003 ¶¶ 162–164 (citing Ex. 1012 ¶¶ 25, 26, 28); *see also* Pet. 29–30 (citing Ex. 1012 ¶¶ 25, 26, 28; Ex. 1003 ¶¶ 162–165).

Connell's calibration feature dynamically determines brake shoe effectiveness data 22 "to determine the ability of the braking arrangement BA to retard the train TR to a specified level, whether a speed level *or a complete stop*." Ex. 1012 ¶ 26 (emphasis added). Additional calibration features use the determined brake shoe effectiveness to calibrate operational parameters such as "a braking curve, i.e., the distance required for the train TR to completely stop" and "a stopping distance." *Id.* ¶ 28.

On this record, we find that Petitioner has established a reasonable likelihood that claim 15 is unpatentable over Grisham and Connell.

K. Ground 2A: Alleged Obviousness Over Grisham and Nixon

Petitioner asserts the unpatentability of claims 7–9, 17–19, 21, and 24–26 under § 103(a) over Grisham and Nixon. Pet. 2–5, 31–38.

1. Nixon (Ex. 1016)

Nixon describes a collision avoidance method and system using trail alert transceiver 100 that transmits identification codes to other trail alert transceivers and outputs sound/light alert signals based on a range and speed estimated from received signals to indicate relative distance (e.g., faster beeping as a target moves closer) of approaching vehicles. Ex. 1016, 1, 5–6.

The trail alert equipment can be applied to any kind of vehicle such as a train, airplane, boat, ship, snowmobile, and ATV. Ex. 1016, 6. The trail alert equipment can position targets by processing the outputs of a vehicle location system such as GPS receivers that receive GPS signals from other trail alert equipment and determine their own position to include displaying the hostile target's position based on the range estimation and displaying their own position determined by the GPS receiver. *Id.* at 6–7.

2. *Claims 7–9*

Regarding claim 7, Petitioner asserts that Nixon uses a GPS receiver with collision avoidance equipment to receive GPS signals to determine the position of the receiver and communicate that position to collision avoidance equipment in a train to determine absolute location. Pet. 31 (citing Ex. 1016, 6–7; Ex. 1003 ¶¶ 169–172). Petitioner contends that skilled artisans would have been motivated to supplement Grisham’s UWB-based collision-avoidance system with the GPS units of Nixon because UWB’s accuracy is range-limited due to low transmission power that reduces its usefulness in stopping long trains. *Id.* at 32. Petitioner also asserts that skilled artisans would have been motivated to supplement data of Grisham’s UWB-based system with heading, acceleration, and other characteristics for collision-avoidance, and a GPS system complements a UWB system by being effective at larger distances. *Id.* at 32–33 (citing Ex. 1003 ¶¶ 173–176).

Patent Owner argues that claim 7 is not unpatentable at least because it depends from claim 1. Prelim. Resp. 30. Patent Owner also asserts that Petitioner’s assertions regarding the motivations of skilled artisans rely only on Mr. Andrews’ Declaration, which parrots what is in the Petition without any support for conclusory assertions regarding what skilled artisans would have understood. Prelim. Resp. 30–31. Patent Owner argues that neither the Petition nor Mr. Andrews explains whether a skilled artisan would have had a reasonable expectation of success in combining Grisham and Nixon to arrive at the claimed invention and Mr. Andrews states only that “UWB and GPS provide positioning data, so it would have been readily apparent to a POSITA how to implement GPS into the radio units from Grisham.” *Id.* at 32 (citing Ex. 1003 ¶ 176).

According to the '227 patent, prior art collision-avoidance systems used GPS and radar-based sensors to monitor locations of rail vehicles but when the systems enter “blackout” areas (buildings, mountains, canyons, tunnels) GPS cannot determine a vehicle’s location accurately. Ex. 1001, 2:57–66. The claimed collision avoidance system introduces redundancy of multiple types of sensors with different accuracies at different distances. *Id.* at 3:28–4:6. In some embodiments, a vehicle mounted module (VMM) 600 transmits absolute position, relative position, speed, and other vehicle data to CTU 630 using GPS unit 610, UWB unit 620, or other sensors. *Id.* at 7:28–63, 11:19–22. VMM 600 may obtain absolute position using GPS unit 610. *Id.* at 7:66–8:2. A UWB unit may work with a GPS unit. *Id.* at 14:55–66.

Petitioner and Mr. Andrews contend that Nixon’s collision avoidance system uses GPS to determine the absolute position of moving vehicles such as trains and provide alerts based on the proximity of vehicles to one another by beeping faster as a target moves closer by relying on teachings in Nixon. Pet. 31 (citing Ex. 1016, 5–7; Ex. 1003 ¶¶ 169–172); Ex. 1003 ¶¶ 94 (citing Ex. 1016, 6–7), 171 (citing Ex. 1016, 6–7), 172 (citing Ex. 1016, 6–7).

Mr. Andrews contends that skilled artisans would augment Grisham’s UWB-based system with Nixon’s GPS because UWB has low transmission power and would benefit from using GPS to measure the absolute position and heading of vehicles. Ex. 1003 ¶¶ 61 (citing Ex. 1025 ¶ 3), 173–176. Mr. Andrews testifies that GPS’s accuracy can vary by several meters, but UWB precisely measures range and refines the accuracy of GPS to prevent collisions at all distances, and GPS offsets shortfalls of UWB, and UWB overcomes limitations on GPS such as tunnels, urban areas, or low satellite visibility. *Id.* ¶¶ 174–176 (citing Nixon; Ex. 1037); *see id.* ¶¶ 61–70.

On this record, we find that Mr. Andrews' testimony is supported sufficiently and, in turn, supports Petitioner's contentions. Any lack of support goes to the weight to be given to Mr. Andrews' testimony.

Mr. Andrews testifies that Grisham discloses a UWB-based collision avoidance system, and Nixon's GPS based collision avoidance system uses GPS position data "so it would have been readily apparent to a POSITA how to implement GPS into the radio units from Grisham." Ex. 1003 ¶¶ 171–176 (citing Ex 1016, 6–7). The level of detail in Grisham, Nixon, and the '227 patent for using UWB and GPS in collision avoidance systems to determine locations and distances between vehicles indicates the technologies are well developed and predictable enough to implement together with a reasonable expectation of success to use a GPS unit in a VMM to receive satellite data as recited in claim 7. *See Intelligent Bio-Sys.*, 821 F.3d at 1367. Nixon also uses GPS and UWB in a collision avoidance system. Ex. 1016, 2–3, 5–14; *see* Pet. 31–32; Ex. 1003 ¶¶ 170–172 (citing Ex. 1016, 6–7). On this record, we find that Petitioner has established a reasonable likelihood that claim 7 is unpatentable over Grisham and Nixon.

Regarding claims 8 and 9, Petitioner asserts that Nixon and Grisham issue alarms to alert an operator to oncoming trains in the vicinity and the warning can be variable in sight or sound (e.g., beeping faster) as a target is moving closer or approaching rapidly in Nixon and it would have been obvious to combine the teachings to distinguish collision alarms from other alarms. Pet. 34–35 (citing Ex. 1006, 23:57–60, 23:57–58, Fig. 21; Ex. 1016, 5–6; Ex. 1003 ¶¶ 177–184). These contentions, which Patent Owner does not contest at this stage, are supported sufficiently by evidence of record.

On this record, we find that Petitioner has established a reasonable likelihood that claims 8 and 9 are unpatentable over Grisham and Nixon.

3. Independent Claim 17

Petitioner contends that elements [17-Pre], [17A], and [17B] track to elements [1-Pre], [1A], [1B], and [1F] and are disclosed by Grisham for the same reasons provided for claim 1 in Ground 1A. Pet. 36.

Regarding elements [17C]–[17G], Petitioner contends that Grisham uses radio units to transmit and receive impulse radio signals wirelessly to provide direction, speed, and separation distance data for each rail vehicle with a single antenna 704 (element [17C], a GPS system to determine an absolute position of a rail vehicle with Nixon as for claim 7 (element [17D], and elements [17E]–[17G] for the same reasons as elements [1C]–[1F] in Ground 1A. Pet. 36–37 (citing Ex. 1006, 16:39–41, 16:59–60, 17:44–48, 23:42–47, Fig. 22; Ex. 1003 ¶¶ 189–194).

Patent Owner argues that Grisham does not disclose the elements of claim 17 for many of the same reasons as argued for claim 1 in Ground 1A and claims 7–9 of this ground by failing to identify a motivation to combine Grisham and Nixon or reasonable expectation of success. Prelim. Resp. 33.

As discussed for claim 7 above, Petitioner asserts that skilled artisans would have been motivated to combine Nixon with Grisham to supplement the range of Grisham’s UWB-based CAS with a complementary technology of Nixon’s GPS. Pet. 31–34 (citing Ex. 1003 ¶¶ 173–176). Nixon describes the use of UWB and GPS in a collision avoidance system. Ex. 1016, 5–14. On this record, we find Petitioner has established a reasonable likelihood that claim 17 is unpatentable over Grisham and Nixon.

4. *Claims 18, 19, 21, and 24–26*

Petitioner contends that claims 18, 19, 21, and 24–26 are unpatentable over Grisham and Nixon citing contentions for element [1B] in Ground 1A for claim 18, claim 14 in Ground 1A for claim 19, claims 8 and 9 of Ground 1A for claim 21, claims 7, 8, and limitations in Ground 1A for claims 24 and 25, and claim 9 in Ground 2A for claim 26. Pet. 37–38 (citing Ex. 1003 ¶¶ 195–209). Patent Owner incorporates its arguments offered for claim 17 (for claims 18, 19, and 21), claims 8 and 9 (for claim 21), elements of claim 1 in Ground 1A for claims 24 and 25, claim 8 for claim 25, and claim 9 for claim 26. Prelim. Resp. 34–35. For reasons discussed for those claims and grounds, on this record, we find that Petitioner has established a reasonable likelihood that claims 18, 19, 21, and 24–26 are unpatentable over Grisham and Nixon.

L. Ground 2B: Alleged Obviousness Over Grisham, Nixon, and Richardson

Petitioner asserts the unpatentability of claim 20 under § 103 over Grisham, Nixon, and Richardson. Pet. 2–5, 39–40. Petitioner contends that skilled artisans would have been motivated to combine Grisham’s UWB-based CAS with features of Nixon’s longer-range GPS CAS and to use Richardson’s auxiliary transponder sensor module with an offset for better location measures and improved collision avoidance. *Id.* at 39–40 (citing contentions for claims 7 and 9 in Ground 2A and claim 5 in Ground 1C; Ex. 1003 ¶¶ 210–212). Patent Owner argues that Petitioner has not shown a motivation to combine Grisham and Nixon or Grisham and Richardson with reasonable expectations of success for the reasons provided for Ground 2A and 1C, respectively. Prelim. Resp. 35–36.

For reasons discussed above for those claims and grounds, on this record, we find that Petitioner has established a reasonable likelihood that claim 20 is unpatentable over Grisham, Nixon, and Richardson.

M. Ground 2C: Alleged Obviousness Over Grisham, Nixon, and Douglas

Petitioner contends that claims 22, 27, and 28 are unpatentable under § 103(a) over Grisham, Nixon, and Douglas for reasons asserted for claims 2 and/or 3 in Ground 1B, and that skilled artisans would have been motivated to use central tracking units on trains to send critical information to other trains and operators using existing collision-avoidance electronics installed on those trains to do so and railway and train-control infrastructure (e.g., a station). Pet. 2–3, 40–41 (citing Ex. 1011, 7:12–19; Ex. 1003 ¶¶ 213–217).

Patent Owner argues that the claims are not unpatentable due to their dependency from claim 17 or 24 and for reasons presented previously for claims 2 and 3 for Ground 1B. Prelim. Resp. 36. For reasons discussed above for those claims and grounds, on this record, we find that Petitioner has established a reasonable likelihood that claims 22, 27, and 28 are unpatentable over Grisham, Nixon, and Douglas.

N. Ground 2D: Alleged Obviousness Over Grisham, Nixon, and McDaniel

Petitioner asserts the unpatentability of claim 10 under § 103(a) over Grisham, Nixon, and McDaniel. Pet. 2–3, 41–42.

1. McDaniel (Ex. 1015)

McDaniel discloses a collision avoidance system that determines threshold warning distances and minimum distances to avoid collisions adaptively based on velocities. Ex. 1015 ¶¶ 1, 38, 39.

2. *Claim 10*

Petitioner contends that McDaniel teaches a controller that sets a minimum threshold warning distance required by host machine 110 to avoid a collision based on respective velocities of a host machine 110 and a target object 130, and skilled artisans would have been motivated to include this feature in Grisham's vehicle mounted module (as supplemented by Nixon's GPS) to avoid collisions more accurately and effectively based on speeds of approaching of trains to avoid nuisance alerts where Grisham uses speed and distance data, and Nixon gives progressive alarms based on a proximity of oncoming trains. Pet. 41–42 (citing Ex. 1015 ¶ 39; Ex. 1003 ¶¶ 218–220).

Patent Owner argues that Petitioner fails to explain how the adaptive threshold feature of McDaniel would work in Grisham's collision avoidance system where McDaniel determines a threshold distance as a function of the velocity and inclination angle of a target and host machine and reaction time due to environmental conditions without “deciphering between target objects that are a true threat and those that are merely a nuisance – *i.e.*, in the context of trains, that would be trains nearby but on a separate and distinct track.” Prelim. Resp. 37–38. Patent Owner also argues that Petitioner fails to explain whether a skilled artisan would have had a reasonable expectation of success in arriving at the claimed invention when McDaniel's adaptive threshold feature is not designed for use in trains. *Id.* at 38–39.

On this record, Petitioner has made a sufficient showing that a skilled artisan would have been motivated to add McDaniel's adaptive threshold feature to Grisham to improve the ability of Grisham's CAS to distinguish trains that present a real threat of collision from those that do not by considering the approaching speeds. Pet. 41–42; *see KSR*, 550 U.S. at 417.

Petitioner has contended that Nixon’s GPS system complements and improves Grisham’s UWB-based CAS by enabling the system to identify the locations and speeds of trains at further distances than UWB can do and the *absolute position*, headings, and acceleration of trains to avoid false alerts such as “where trains operate safely in close proximity to one another on different tracks” that a UWB radar might not distinguish and issue a false alert as a result. Pet. 32–34. McDaniel’s adaptive threshold warning system would enhance the CAS of Grisham and Nixon and avoid nuisance alerts to the operator of the safe approach or close proximity of other trains “given the number of trains that can safely be positioned within feet of each other in, for example, a train yard.” *Id.* at 41–42. McDaniel implements such a system that modifies one or more vehicle separation thresholds based on the speed of a first vehicle and the speed of a second vehicle for large vehicles as claimed. Ex. 1015 ¶¶ 16, 39. Claim 10 does not require “deciphering between target objects that are a true threat and those that are merely a nuisance – *i.e.*, in the context of trains, that would be trains nearby but on a separate and distinct track” as Patent Owner argues. Prelim. Resp. 38. This argument is not commensurate with the scope of the claim and not relevant to a reasonable expectation of success inquiry. *See Intelligent Bio-Sys.*, 821 F.3d at 1367. Moreover, Petitioner has explained how Grisham and Nixon’s GPS might address these concerns as discussed. *See* Pet. 32–34.

On this record, we find that Petitioner has established a reasonable likelihood that claim 10 is unpatentable over Grisham, Nixon, and McDaniel.

O. Ground 2E: Alleged Obviousness Over Grisham, Nixon, McDaniel, and Connell

Petitioner asserts the unpatentability of claim 16 under § 103(a) over Grisham, Nixon, McDaniel, and Connell. Pet. 2–5, 43. Petitioner contends that claim 16’s limitations track those of claims 9 and 10 and are satisfied for the same reasons as explained for claim 9 in Ground 2A and claim 10 in Ground 2D, and skilled artisans would have been motivated to incorporate McDaniel’s adaptive threshold warning system and Connell’s stopping distance calibration feature for vehicle collision avoidance into Grisham and Nixon’s CAS to avoid collisions more accurately and effectively when rail vehicles approach at different speeds or braking conditions and to avoid nuisance alerts. Pet. 43 (citing Ex. 1003 ¶¶ 221, 222).

Patent Owner argues that claim 16 is not unpatentable for the same reasons as claim 1 and claims 9 and 10, and Petitioner has not provided substantive reasoning to combine the references. Prelim. Resp. 39–40.

Petitioner has provided rationales to combine their teachings. Pet. 43 (incorporating reasons asserted for claim 15 in Ground 1E and claim 10 in Ground 2D and citing Ex. 1003 ¶¶ 221, 222 (Connell’s measurements would improve the accuracy of the adaptive threshold)). On this record, we find that Petitioner has established a reasonable likelihood that claim 16 is unpatentable over Grisham, Nixon, McDaniel, and Connell

P. Ground 2F: Alleged Obviousness Over Grisham, Nixon, McDaniel, Connell, and Breed

Petitioner asserts the unpatentability of claim 23 under § 103(a) over Grisham, Nixon, McDaniel, Connell, and Breed. See Pet. 2–5, 43–44.

Petitioner contends that Breed discloses the limitations of claim 23 for the reasons Breed discloses the same limitations in claim 12 in Ground 1D, and skilled artisans would have been motivated to combine Breed and the other references to use Breed's inertial measurement units, accelerometers, and gyroscopes to provide accurate speed and acceleration data beyond the working range of UWB and to provide heading information for a train-safety system for the reasons discussed for claim 16 in Ground 2E and claim 12 in Ground 1D. Pet. 43–44 (citing Ex. 1003 ¶¶ 223, 224).

Patent Owner argues that claim 23 is not unpatentable for the same reasons as claim 12, and Petitioner has provided no substantive reasoning to justify why a skilled artisan would have combined these references together. Prelim. Resp. 40; *cf.* Pet. 43–44 (providing reasons to combine teachings).

On this record, we find that Petitioner has established a reasonable likelihood that claim 23 is unpatentable over Grisham, Nixon, McDaniel, Connell, and Breed.

Q. Ground 3A: Alleged Obviousness Over Suzuki or Over Suzuki and Grisham

Petitioner asserts unpatentability of claims 1, 7, 8, 11–14, 17–19, 24, and 25 under § 103(a) over Suzuki alone or in combination with Grisham. *See* Pet. 2–5, 44–67.

1. Suzuki (Ex. 1005)

Suzuki disclose a collision avoidance system that uses UWB devices for communication and radar/ranging functions. Ex. 1005 ¶ 57. The system measures distances to an obstacle or a front vehicle using a radar function and issues a hazard warning to the driver if the distance is a predetermined amount or less. *Id.* ¶¶ 8, 18, 28, 37, 57.

2. *Claim 1*

Regarding element [1-Pre], Petitioner contends that Suzuki teaches a collision-avoidance system. Pet. 47 (citing Ex. 1005, Code (57), ¶ 8; Ex. 1003 ¶¶ 227–229). This contention, which Patent Owner does not contest at this stage, is supported sufficiently by evidence of record. Suzuki discloses a UWB device with communication and radar functions to measure distances between cars and, based on that distance, issue a warning to a driver or carry out a pre-crash operation. Ex. 1005, Code (57), ¶¶ 8, 18, 28.

Regarding element [1A], Petitioner contends that Suzuki discloses in-vehicle radar 110 in different configurations and a dual-radar system with a user interface to warn drivers and the radar and user interface are mounted as a vehicle mounted module with units discussed for elements [1B]–[1D]. Pet. 47–49 (citing Ex. 1005 ¶¶ 35, 36, Figs. 1B, 3, 8; Ex. 1003 ¶¶ 230–232).

a. *Unpatentability Over Suzuki Alone*

Petitioner asserts that skilled artisans would understand teachings of Suzuki apply to all ground vehicles, including rail vehicles, because Suzuki refers generally to “vehicles” throughout its disclosure and only sometimes specifies that vehicles are “cars,” and skilled artisans would understand that some railroad work vehicles are dual-mode work vehicles, road-rail vehicles, or hi-rail trucks that “are essentially motor vehicles or cars with the ability to operate on tracks and road.” Pet. 46, 49 (citing Ex. 1003 ¶¶ 233–235).

Mr. Andrews testifies that skilled artisans would understand that these teachings apply to all vehicles including dual-mode rail vehicles that operate on tracks and roads, would avoid collisions of rail and road vehicles, and could be applied to rail vehicles with minimal changes because they have fewer degrees of freedom of movement than cars. Ex. 1003 ¶¶ 233–235.

Patent Owner argues that Suzuki measures separation distances of vehicles that are close to each other but the '227 patent “recognizes, to avoid crashes between rail vehicles, the devices must be capable of measuring separation distances where the rail vehicles are far apart.” Prelim. Resp. 41–42 (citing Ex. 1001, 23:32–35). Patent Owner argues that a skilled artisan would recognize that Suzuki would not be able to measure longer separation distance and would not have a reasonable expectation of success of arriving at a collision avoidance system for rail vehicles recited in claim 1. *Id.* at 42.

According to the '227 patent, its collision avoidance system (CAS) provides techniques and solutions for a wide variety of railway vehicles such as maintenance vehicles, railcars, hyrail cars, train cars, and engines such as illustrated in Figures 1A–1C. Ex. 1001, 3:43–60. Figure 1C depicts a hyrail vehicle that can operate on railroad tracks and roads. *Id.* at 3:51. The CAS may combine sensors to detect vehicles that are far away or inches away. *Id.* at 4:2–6. A GPS unit and UWB offer distance measurements of different ranges and precision. *Id.* at 17:6–26. The VMM equipment may sense the closest targets in the front and in the back. *Id.* at 22:8–12. A host vehicle may be 50 feet behind a target vehicle. *Id.* at 23:8–19. Separation distances can be 40 feet and 100 feet. *Id.* at 23:33–45. The '227 patent's CAS may be used in other vehicles, applications, and industries including construction, mining, and airport (on airport tarmacs) industries. *Id.* at 29:30–38.

Claim 1 does not require a particular separation distance or sensor with a particular capability to sense or detect a particular distance range. Patent Owner's arguments in this regard are not commensurate with the scope of claim 1 (or claims 17 and 24). Prelim. Resp. 41–42. Suzuki uses *cognitive radio* to expand coverage. *See* Ex. 1005 ¶¶ 40–49, Figs. 9–11.

Petitioner has provided sufficient evidence at this stage to support a determination that a skilled artisan would have considered Suzuki's collision avoidance system applicable to railroad vehicles, particularly hyrail vehicles that operate on roads and railroad tracks as the '227 patent discloses for its CAS. Ex. 1001, 3:43–47, Fig. 1C. Mr. Andrews testifies that Suzuki's system could be applied to rail vehicles with a reasonable expectation of success as such rail vehicles present simpler technical problems and fewer degrees of freedom than vehicles that operate on roads. Ex. 1003 ¶ 234. Mr. Andrews also provides persuasive testimony at this stage that a skilled artisan would consider Suzuki's system for use in rail vehicles because the mounting would require less complexity than for cars. *Id.* ¶ 235.

b. Unpatentability Over Suzuki and Grisham

Petitioner also contends, “using Suzuki's collision-avoidance system on rail vehicles would have been obvious to POSITAs in view of Grisham.” Pet. 46 (citing Ex. 1003 ¶¶ 236–242), 49–52 (same). Petitioner asserts that Grisham's collision avoidance system uses UWB communications and displays to provide user alerts and inputs for rail vehicles that travel on tracks, trains, and conventional cars so that skilled artisans would have been motivated to apply Suzuki's collision-avoidance system to rail vehicles and to mount modules and other components on rail vehicles with a reasonable expectation of success because both references address the same problem of vehicular collision avoidance in substantially the same way for vehicles such as cars (Suzuki) and cars, work vehicles, and trains (Grisham). *Id.* at 49–51 (citing contentions for elements [1A]–[1D] in Ground 1A; Ex. 1006, 19:20–20:14, 22:42–23:32, Figs. 11, 19; Ex. 1003 ¶¶ 236–240).

Petitioner contends that Grisham teaches how to use its rail system in a car and the benefits of a collision avoidance system with UWB sensors in rail vehicles so it would have been a trivial modification for skilled artisans to apply the vehicle mounted modules of Suzuki to rail vehicles as taught by Grisham where Grisham teaches the interoperability and compatibility of providing collision avoidance between cars and rail vehicles as taught by Grisham's car-train embodiment. Pet. 51 (citing Ex. 1003 ¶¶ 236–242).

Patent Owner argues that Mr. Andrews' Declaration is not supported by evidence such as his conclusion that skilled artisans would understand from reading Grisham that rail systems and car systems would provide the greatest benefit when they are compatible with each other. Prelim. Resp. 42 (citing Ex. 1003 ¶¶ 239–242). Patent Owner asserts that Mr. Andrews' testimony does not provide substantial evidence and disregards differences between car and train collision avoidance systems such as the fewer degrees of freedom of movement of rail vehicles compared to cars and does not explain why a skilled artisan would be motivated to replace Grisham's train-based system with Suzuki's car-based system. *Id.* at 42–43.

Petitioner and Mr. Andrews rely on Grisham's teachings of collision-avoidance systems that use UWB communications and displays for alerts and user inputs for rail vehicles, dual mode hi-rail vehicles, trains, and cars and systems that prevent collisions between rail vehicles and cars. Pet. 46, 49–59 (citing contentions for elements [1A]–[1D] in Ground 1A; Ex. 1006, 19:20–20:14, 22:42–23:32, Figs. 11, 19); Ex. 1003 ¶¶ 233, 236–242 (citing Ex. 1006, 22:42–49, 23:33–40, Figs. 11, 12, 19, 21; Ex. 1036); Ex. 1003 (citing 1006, 22:28–30, 22:42–49, 23:33–40, Figs. 11, 12, 19, 21; Ex. 1033; Ex. 1034; Ex. 1035).

Figures 11 and 12 of Grisham describe a collision avoidance process for vehicle 1104 at railroad crossing 1106 to receive impulse radio signal 910 from transmitting impulse radio unit 902 on a locomotive 1102 that is approaching railroad crossing 1106 at receiving impulse radio unit 904 on vehicle 1104 to alert the vehicle operator of a potentially dangerous situation of the presence of locomotive 1102. Ex. 1006, 19:20–54, Figs. 11, 12.

Grisham’s teaching of the combinability and interoperability of UWB units for trains, rail vehicles, and cars provides a rational underpinning to apply Suzuki’s CAS to rail vehicles for similar benefits with a reasonable expectation of success in less complex trains. Ex. 1006, 18:52–24:44. Grisham provides a road map for doing so. *See* Ex. 1003 ¶¶ 239–242.

c. Remaining elements of claim 1

Regarding element [1B], Petitioner contends that Suzuki teaches an in-vehicle UWB radar device 110 that sends, via antenna 121A, radar waves and data with vehicle location and ID information and receives radar waves and data via antenna 121B and the antennas can be shared as antenna 121C. Pet. 52–53 (citing Ex. 1005, Code (57) ¶¶ 14, 15, 20, 27, Figs. 1B, 2, 3, 8; Ex. 1003 ¶¶ 243–246. These contentions, which Patent Owner does not contest at this stage, are supported sufficiently by evidence of record.

Regarding element [1C], Petitioner contends that Suzuki’s control part 123 is part of radar device 110 that sends commands to the transceivers and processes information from front- and rear-mounted devices in integral unit 310 and skilled artisans would understand the information processing to be done by a processor. Pet. 54 (citing Ex. 1005 ¶¶ 14, 35, 36, Figs. 1B, 3, 8; Ex. 1003 ¶ 247). These contentions, which Patent Owner does not contest at this stage, are supported sufficiently by evidence of record.

Regarding element [1D], Petitioner contends that Suzuki has a display that is operable to provide vehicle information as a warning to a driver when the distance between two vehicles is less than a predetermined value or as an alarm display or alarm tone when a short time to crash is calculated, and it would have been obvious for the display to receive input from an operator to mute the alarm or adjust the volume and to provide rail-vehicle information just as readily as vehicle information because cars and rail vehicles face the same problem of avoiding collisions and applying a warning/alarm for cars to rail vehicles would not require any substantial modifications. Pet. 54–55 (citing element [1A], Ground 3A; Ex. 1005 ¶¶ 8, 18, 28, 37; Ex. 1003 ¶¶ 248–252; Ex. 1001, 18:14–16).

Petitioner contends in the alternative that Suzuki and Grisham render this element obvious through Grisham’s teaching of a user interface module with a display that provides information and receives input from an operator to communicate with other operators, and skilled artisans would have been motivated to combine Suzuki’s collision avoidance system with warnings and alarms with Grisham’s display to provide rail vehicle information and receive operator input to mute the alarm and adjust the volume with a reasonable expectation of success. Pet. 55–56 (citing element [1D] in Ground 1A; element [1A] in ground 3A; Ex. 1003 ¶¶ 253, 254).

Patent Owner argues that Petitioner contends that it would have been obvious that the warning and alarm displays and navigation system disclosed in Suzuki would receive input from the driver such as muting the alarm and adjusting the volume and the Petitioner relies on Mr. Andrews to support its contention, but Mr. Andrews repeats, verbatim, the conclusory assertion for which it is offered to support. Prelim. Resp. 43–44.

Mr. Andrews testifies that it would have been obvious for a warning and alarm display and navigation system to receive driver input to mute and adjust alarms and volumes, and such Automotive Navigation Systems 312 of Suzuki were known to allow operators to input a destination into the system for guidance. Ex. 1003 ¶ 251.

Patent Owner also argues that the Petition's reliance on Grisham fails because Grisham does not disclose this element. Prelim. Resp. 44.

Petitioner cites element [1D] of Ground 1A to support its contentions that Suzuki and Grisham render obvious a display that receives user input in element [1D] of Ground 3A. Pet. 55–56. Element [1D] of Ground 1A relies on Grisham to teach a display that displays direction, distance, and speed of an oncoming train to a vehicle operator (Ex. 1006, 23:52–66) and allows the operator to communicate with operators on another train (*id.* at 23:60–62). Pet. 14 (citing Ex. 1006, 23:52–66 to disclose element [1D] of Ground 1A). These teachings support Petitioner's contentions.

Regarding element [1E], Petitioner contends that Suzuki's UWB device sends signals with location data or vehicle ID to a UWB device mounted on another vehicle. Petitioner asserts it would be obvious to mount Suzuki's in-vehicle radar devices on rail vehicles for the same reasons as element [1A] of Ground 3A to provide an approaching locomotive warning to an operator of another train. Pet. 56 (citing Ex. 1005 ¶¶ 8, 15, 16, 55, Figs. 8, 17, 19–22; Ex. 1003 ¶¶ 255–260). These contentions, which Patent Owner does not contest, are supported sufficiently by evidence of record. Suzuki's system combines vehicle-to-vehicle communication and a radar function to measure distances to objects around a vehicle using UWB devices to warn drivers. Ex. 1005 ¶¶ 7, 8, 14, 16, 27, 45, 51–57.

Grisham further discloses the benefits of mounting communication modules on locomotives and work vehicles to communicate the position and distance of such vehicles to one another and to alert vehicle operators of dangerous situations. Ex. 1006, 22:33–60, Figs. 19–22; *see* Pet. 49–52.

Regarding element [1F], Petitioner contends that Suzuki’s in-vehicle devices use a time of flight technique to determine the distance between vehicles, and it would have been obvious to use this technique to determine separation distances of rail vehicles. Pet. 57 (citing Ex. 1005 ¶¶ 4, 32; Ex. 1003 ¶¶ 261–264. These contentions, which Patent Owner does not contest, are supported sufficiently by evidence of record. *See* Ex. 1005 ¶¶ 8, 32.

On this record, we find that Petitioner has established a reasonable likelihood that claim 1 is unpatentable over Suzuki alone or in combination with Grisham.

3. *Claims 7, 8, 11–14, 17–19, 24, 25*

Regarding claim 7, Petitioner asserts that Suzuki uses a GPS unit with in-vehicle radar device 110 to receive GPS satellite signals via antenna 124 and measure its position that it transmits to a vehicle-to-vehicle distance measurement part 126, and it would have been obvious in view of Suzuki alone or in view of Grisham to mount Suzuki’s modules on rail vehicles to use GPS to determine a rail vehicle’s position. Pet. 58–59 (citing Ex. 1005 ¶¶ 13, 21, 45, Figs. 1B, 3, 8 (element 312); Ex. 1003 ¶¶ 265–267, 269; discussion in element [1A] of Ground 3A). Petitioner asserts that Suzuki’s GPS unit communicates with a control electronics module of automotive navigation system 312 using location information acquisition part 185 and control part 123 in Figure 3 and in-vehicle network 314 in Figure 8. Pet. 59 (citing Ex. 1005 ¶ 21, Figs. 3, 8; Ex. 1003 ¶ 268).

These contentions, which Patent Owner does not contest, are supported sufficiently by evidence of record. Ex. 1005 ¶¶ 13, 21, Fig. 8.

Regarding claim 8, Petitioner asserts that Suzuki receives information from UWB radios and GPS to determine whether vehicle separation criteria are violated and generates a warning signal if they are violated, and it would have been obvious to use this warning for rail vehicles. Pet. 59–61 (citing Ex. 1005 ¶¶ 18, 29, 30–34, 45, Fig. 7; Ex. 1003 ¶¶ 270–273; discussion in element [1A] of Ground 3A). These contentions, which Patent Owner does not contest, are supported sufficiently by evidence of record. *See* Ex. 1005 ¶¶ 29–34, Fig. 7 (steps 502–505, 507–511).

Regarding claim 11, Petitioner contends that Suzuki teaches a ground-speed-detection module that determines a vehicle's speed and communicates it to the vehicle mounted module and it would have been obvious to use this speed detection module to determine a rail vehicle's speed using the same off-the-shelf components as vehicles. Pet. 61 (citing Ex. 1005 ¶¶ 23, 29; element [1A] for Ground 3A; Ex. 1003 ¶¶ 274–276). Petitioner contends that skilled artisans would have been motivated to combine Suzuki's collision avoidance and speed detection with Grisham's speed detection to determine rail vehicle speed as a simpler technical problem for Grisham's vehicle-mounted radio units and UWB units using the measurements of the UWB units, particularly when one of the radio units is located on a control box or railroad pole. *Id.* at 61–62 (citing Ex. 1006, 23:64–24:24; elements [1B], [1C] in Ground 1A; element [1A] in Ground 3A; Ex. 1003 ¶¶ 277–278). These contentions, which Patent Owner does not contest, are supported sufficiently by record evidence. Ex. 1006, 19:2–22:40, Figs 13–18 (using fixed radio units to measure rail vehicle speed and warn cars).

Regarding claim 12, Petitioner contends that Suzuki's system uses an inertial measurement unit (acceleration sensor that detects acceleration and deceleration in a traveling direction) that is operable to detect changes in a vehicle's speed, and it would have been obvious to use speed detection for rail vehicles. Pet. 62–63 (citing Ex. 1005 ¶ 23, Fig. 16; Ex. 1003 ¶¶ 279–284). Petitioner also contends that a skilled artisan would combine Suzuki's speed detection with Grisham's collision avoidance system to detect changes in a rail vehicle's speed (*id.* at 64 (citing element [1A] and claim 11, Ground 3A); Ex. 1003 ¶ 284)), and skilled artisans would understand this sensor to include accelerometers or gyroscopes (*id.* (citing claim 12 for Ground 3A; Ex. 1003 ¶¶ 285, 276)). These contentions, which Patent Owner does not contest, are supported sufficiently by evidence of record.

Regarding claim 14, Petitioner asserts that Suzuki's UWB unit can vary center frequencies. Pet. 65 (citing Ex. 1005 ¶¶ 42, 50; Ex. 1003 ¶¶ 287–290). This contention, which Patent Owner does not contest, is supported sufficiently by evidence of record.

Regarding claim 17, Petitioner asserts that elements [17-Pre], [17A], and [17B] track elements [1-Pre], [1A], [1B], and [1F] and are taught by Suzuki alone or with Grisham for the same reasons as claim 1 in Ground 3A. Pet. 65 (citing Ex. 1003 ¶¶ 291–294). These contentions, which Patent Owner does not contest, are supported sufficiently by evidence of record.

Regarding element [17C], Petitioner asserts that Suzuki has a wireless antenna that sends and receives data, and this antenna 121C (Fig. 2) in radar device 110 would reduce cost and save space. Pet. 65 (citing element [1B], Ground 3A; Ex. 1005, Fig. 2; Ex. 1003 ¶ 295). This contention, which Patent Owner does not contest, is supported sufficiently by record evidence.

Petitioner makes similar contentions for elements [17D]–[17G] citing previous contentions for similar elements in claim 1 or claim 7. Pet. 65–66. These contentions, which Patent Owner does not contest, are supported sufficiently by record evidence.

Petitioner’s contentions for claims 18, 19, 24, and 25 cite contentions for other claims and elements in Ground 3A with the same limitations. Pet. 66–67. These contentions, which Patent Owner does not contest, are supported sufficiently by record evidence.

On this record, we find that Petitioner has established a reasonable likelihood that claims 1, 7, 8, 11–14, 17–19, 24, and 25 are unpatentable over Suzuki alone or over Suzuki and Grisham.

R. Ground 3B: Alleged Obviousness Over Suzuki and Richardson or Over Suzuki, Grisham, and Richardson

Petitioner asserts the unpatentability of claims 2–6, 20, 22, 27, and 28 under § 103(a) over Suzuki and Richardson or Suzuki, Grisham, and Richardson. Pet. 2–5, 67–74. Regarding claims 2–4, Petitioner asserts that Suzuki controls a platoon of vehicles, each with in-vehicle radar device 110 and multiple radars (Fig. 8), and Richardson controls a convoy with multiple UWB units and a UWB controller (central tracking unit) with four mounted UWB radios on each vehicle to receive position information from vehicle mounted modules of other vehicles and its own four UWB radios, and it would have been obvious to combine these teachings to improve safety and prevent collisions of vehicles in Suzuki and/or Grisham with a reasonable expectation of success and using a discrete housing for protection from the elements. Pet. 67–71 (citing Ex. 1005 ¶¶ 55, 56, Fig. 8; Ex. 1008, 209–210, 212, Figs. 1, 2; Ex. 1003 ¶¶ 313–323).

Patent Owner argues that neither Petitioner nor Mr. Andrews explains why a skilled artisan would look to improve the collision avoidance system of Suzuki and Grisham or how those systems would benefit from using Richardson's CTUs. Prelim. Resp. 46.

Mr. Andrews testifies that Suzuki controls a platoon of vehicles using in-vehicle radar devices to control each vehicle, and Richardson describes a control system for a convoy of vehicles using a central controller to manage four radios on each truck to track vehicles in front and behind the vehicle and such ranging and detection in Richardson would improve safety and control over Suzuki's vehicles by monitoring the location of, and distance between, vehicles in a unified way. Ex. 1003 ¶¶ 313–321 (citing Ex. 1005 ¶¶ 55, 56; Ex. 1008, 210, 212, Figs. 1, 2) (cited in Pet. 67–70).

Richardson describes dilution of precision problems that can occur in measuring distances between vehicles in convoys with multiple radios due to geometry and minimizes these issues by defining eight zones for coordinate radio pairs. Ex. 1008, 212–213, Figs. 6, 7; *see KSR*, 550 U.S. at 417.

Petitioner relies on its contentions for claims 5 and 6 in Ground 1B for claims 5, 6, and 20 in Ground 3B, contentions for claims 2 and 3 in Ground 3B for claim 22 in Ground 3B, contentions in claim 2 of Ground 3B for claim 27 in Ground 3B, and contentions for claim 3 in Ground 3B for its contentions for claim 28 in Ground 3B. Pet. 71–74 (citing Ex. 1003 ¶¶ 324–347). These contentions, which Patent Owner does not contest, are supported sufficiently by record evidence discussed above for these claims and grounds. On this record, we find that Petitioner has established a reasonable likelihood that claims 2–6, 20, 22, 27, and 28 are unpatentable over Suzuki and Richardson or over Suzuki, Grisham, and Richardson.

S. Ground 3C: Alleged Obviousness Over Suzuki and Nixon or Over Suzuki, Grisham, and Nixon

Petitioner asserts the unpatentability of claims 9, 21, and 26 under § 103(a) over Suzuki and Nixon or Suzuki, Grisham, and Nixon. Pet. 2–5, 74–75. Petitioner asserts that Suzuki alone or with Grisham teaches and suggests alerts based on vehicle separation distances, and Nixon teaches a progressive warning signal that would have been obvious to combine with Suzuki and/or Grisham to improve their alarms and prevent collisions with a reasonable expectation of success in claim 9. Pet. 74–75 (citing elements [1D], [24F], and [24G] of Ground 3A; claim 9, Ground 2A; Ex. 1003 ¶¶ 348–351). Petitioner relies on its contentions for claim 8, Ground 3A for claim 21 and its contentions for claim 9, Ground 3C for claim 26. Pet. 75 (citing Ex. 1003 ¶¶ 352–354).

Patent Owner argues that Petitioner failed to provide a motivation to combine Nixon and Grisham or a reasonable expectation of success and Mr. Andrews’ declaration is full of conclusory statements for the same reasons as Ground 2A. Prelim. Resp. 47–48. Yet, Petitioner contends that Nixon’s progressive warning feature would improve the alarms in Suzuki and/or Suzuki and Grisham to alert a vehicle operator progressively as collision risk increases, and Mr. Andrews relies on teachings of Nixon to support these contentions. Pet. 74–75 (citing Ex. 1003 ¶¶ 348–351 (citing Ex. 1016, 5–6)).

On this record, we find that Petitioner has established a reasonable likelihood that claims 9, 21, and 26 are unpatentable over Suzuki and Nixon or over Suzuki, Grisham, and Nixon.

T. Ground 3D: Alleged Obviousness Over Suzuki and Connell or Over Suzuki, Grisham, and Connell

Petitioner asserts the unpatentability of claim 15 under § 103 over Suzuki and Connell or Suzuki, Grisham, and Connell. Pet. 2–5, 75–76.

Petitioner relies on its contentions for claim 15, Ground 1E that Connell discloses a stopping-distance calibration feature that would have been obvious to include in Suzuki or Suzuki and Grisham to avoid collisions between vehicles at varying conditions. Pet. 75–76 (citing Ex.1003 ¶¶ 355, 356).

Patent Owner argues that Petitioner failed to provide a motivation to combine Connell with Suzuki alone or with Grisham with a reasonable expectation of success. Prelim. Resp. 48.

Yet, Petitioner has contended that this feature would improve the CAS systems of Suzuki and Grisham to avoid collisions in varying conditions that affect a vehicle’s stopping distance and decrease its stopping ability. Pet. 30 (citing Ex. 1003 ¶¶ 166–168), 75–76 (citing Ex.1003 ¶¶ 355, 356).

Mr. Andrews incorporates his testimony for claim 15, Ground 1E that Connell teaches this feature and that it would have improved the ability of Grisham’s system to avoid collisions in different conditions that affect stopping distances. *See* Ex. 1003 ¶¶ 162–168 (citing Ex. 1012 ¶¶ 25, 26, 28) (contentions for claim 15, Ground 1E).

On this record, we find that Petitioner has established a reasonable likelihood that claim 15 is unpatentable over Suzuki and Connell or Suzuki, Grisham, and Connell.

U. Ground 3E: Alleged Obviousness Over Suzuki, Nixon, and McDaniel or Over Suzuki, Grisham, Nixon, and McDaniel

Petitioner asserts the unpatentability of claim 10 under § 103(a) over Suzuki, Nixon, and McDaniel or Suzuki, Grisham, Nixon, and McDaniel. Pet. 2–5, 76. Petitioner relies on its contentions for claim 9, Ground 3C and claim 10, Ground 2D including the reasons provided therein to modify alarm thresholds of a CAS to avoid collisions between vehicles at varying speeds and conditions. Pet. 76 (citing Ex. 1003 ¶¶ 357, 358).

Patent Owner argues that Petitioner’s contentions for Ground 3C (and 2A) do not provide a motivation to combine or a reasonable expectation of success. Prelim. Resp. 48–49. Petitioner cites Mr. Andrews who testifies that McDaniel renders obvious claim 10, Ground 2D with Grisham and Nixon to avoid collisions when rail vehicles approach at different speeds and to avoid nuisance alerts. Ex. 1003 ¶¶ 357, 358 (citing Sections VIII.N.1. for claim 9, Ground 3C and VIII.I.1 for claim 10, Ground 2D); Ex. 1003 ¶¶ 218–220 (citing Ex. 1015 ¶¶ 38, 39 for claim 10, Ground 2D).

On this record, we find that Petitioner has established a reasonable likelihood that claim 10 is unpatentable over Suzuki, Nixon, and McDaniel or Suzuki, Grisham, Nixon, and McDaniel.

V. Ground 3F: Alleged Obviousness Over Suzuki, Nixon, McDaniel, and Connell or Over Suzuki, Grisham, Nixon, McDaniel, and Connell

Petitioner asserts the unpatentability of claims 16 and 23 under § 103(a) over Suzuki, Nixon, McDaniel, and Connell or Suzuki, Nixon, McDaniel, Connell, and Grisham. Petitioner cites its contentions for claim 9, Grounds 2A, 3C and claim 10, Grounds 2D, 3E for claim 16 and for claim 12, Ground 3A for claim 23. Pet. 76–77 (citing Ex. 1003 ¶¶ 359–362).

Patent Owner argues these claims are not unpatentable because they depend from claim 1, and the Petition failed to establish that a skilled artisan would be motivated to make the asserted combinations. Prelim. Resp. 49–50. Yet, Petitioner relies on testimony of Mr. Andrews who testifies this combination would have been obvious. Ex. 1003 ¶¶ 359–362; Ex. 1003 ¶¶ 348–351 (citing Ex. 1016, 5–6), 357–358 (and sections cited therein)).

On this record, we find that Petitioner has established a reasonable likelihood that claims 16 and 23 are unpatentable over Suzuki, Nixon, McDaniel, and Connell or Suzuki, Grisham, Nixon, and McDaniel, Connell.

III. CONCLUSION

For the reasons discussed above, we are persuaded that Petitioner has demonstrated a reasonable likelihood of prevailing in establishing that at least one of claims 1–28 of the '227 patent is unpatentable.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that *inter partes* review of the '227 patent is hereby instituted as to claims 1–28 on all grounds set forth in the Petition; and

FURTHER ORDERED that pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4, notice is hereby given of the institution of a trial on the grounds of unpatentability authorized above; the trial commences on the entry date of this decision.

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