

Paper No. ____

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.,
Petitioners,

v.

METROM RAIL, LLC,
Patent Owner.

Case No. IPR2023-00452
Patent No. 10,778,363

PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.1 *et seq.*

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APPENDIX LISTING OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 10,778,363 (“the ’363 patent”)
1002	Prosecution History of U.S. Patent No. 10,778,363
1003	Declaration of Aron Kain, Ph.D.
1004	CV of Aron Kain, Ph.D.
1005	U.S. Patent Publication No. 2015/0329130 (“Carlson”)
1006	U.S. Patent Publication No. 2012/0296562
1007	U.S. Patent Publication No. 2009/0253439 (“Gantner”)
1008	European Patent No. 2,571,742 (“Ghaly”)
1009	U.S. Patent No. 7,725,252 (“Heddebaut”)
1010	U.S. Patent Publication No. 2016/0046308
1011	U.S. Patent Publication No. 2007/0293153
1012	Int. J. ITS Res., “Assessment of the Contribution of Time Reversal of a UWB Localization System for Railway Application”
1013	U.S. Patent Publication No. 2013/0138276
1014	U.S. Patent No. 9,434,397
1015	Docket as of January 9, 2023 for <i>Metrom Rail, LLC v. Siemens Mobility, Inc., et al.</i> , 1-22-cv-00049 (D. Del.)
1016	First Amended Complaint, <i>Metrom Rail, LLC v. Siemens Mobility, Inc., et al.</i> , 1-22-cv-00049, Dkt. No. 32 (D. Del. Apr. 26, 2022)
1017	The Free Dictionary.com Definition of “Broadcasting”
1018	ETSI Technical Report 101 538 V1.1.1 (2012-10)
1019	IEEE Std 802.15.4™-2011, IEEE Standard for Local and Metropolitan Area Networks: Part 15.4: Low-Rate Wireless Personal Area Networks
1020	U.S. Patent Publication No. 2015/0097412
1021	U.S. Patent Publication No. 2004/0240565
1022	U.S. Patent Publication No. 2010/0235460

1023	U.S. Patent Publication No. 2010/0039978
1024	U.S. Patent No. 9,606,217
1025	U.S. Patent No. 5,452,870
1026	CCS: A Railway Corridor Control System Utilizing Ultra Wideband Radio Technology (2004)
1027	Newton's Telecom Dictionary (27th ed 2013)
1028	Dictionary of Computer Science, Engineering, and Technology (2001)
1029	Microsoft Computer Dictionary (5th Ed. 2002)
1030	Time Domain's Ultra Wideband (UWB) Definition and Advantages, Time Domain (March 2011)
1031	U.S. Patent No. 6,631,322
1032	U.S. Patent Publication No. 2006/0009240

I. MANDATORY NOTICES

A. Real Party-In-Interest – § 42.8(b)(1)

Petitioners Siemens Mobility, Inc., Ground Transportation Systems USA Inc., Humatics Corp., and Piper Networks, Inc. are the real parties-in-interest. Thales USA, Inc. is also a real party-in-interest.

B. Related Matters – § 42.8(b)(2)

1. United States Patent & Trademark Office

U.S. Patent No. 10,778,363 (“the ’363 patent”) is a continuation of application No. 16/290,576, which claims priority to U.S. Provisional Application No. 62/637,774 and which is a continuation-in-part of U.S. Patent Application No. of application No. 16/055,905 which claims priority to U.S. Provisional Application No. 62/541,454. The earliest possible effective filing date of the ’363 patent is August 4, 2017, without conceding that the claims of the ’363 patent are entitled to this priority date.

2. District Court Matters

The ’363 patent is at issue in the following pending case: *Metrom Rail, LLC v. Siemens Mobility, Inc., et al.*, 22-cv-00049-RGA (D. Del.).

C. Counsel and Service Information – § 42.8(b)(3) and (b)(4)

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Powers of attorney are submitted with this petition. Counsel for Petitioners consent to service of all documents via electronic mail.

Petitioners request *inter partes* review of claims 1-16 of the '363 patent.

II. INTRODUCTION

The '363 patent describes “decentralized” train-control systems in which trains perform certain functions—*e.g.*, stopping/slowng—autonomously. EX1001, Abstract, 4:12-24. To perform functions autonomously, trains use ultra-wide band (UWB) radios to range with UWB radios on other trains and/or on “anchors” located along the track. EX1001, 4:19-60. The train’s on-board computer uses the UWB-based ranging information to identify the train’s speed and position, which it then uses to determine if an action should occur—*e.g.*, stopping/slowng because the distance to another train is too close.

“Decentralized” train-control systems existed long before August 4, 2017, the '363 patent’s earliest alleged priority date. For example, Ghaly (EX1008) was filed years earlier and describes a system of “intelligent” trains that self-regulate their movement based on location and speed. Moreover, using UWB radios to precisely determine a train’s location and/or speed was conventional. Indeed, that “idea” was published by a standards-setting organization in 2012 (EX1018) and was the subject of several other prior-art publications. Given the conventional nature of the subject matter to which they are directed, the challenged claims are—unsurprisingly—unpatentable.

Ground 1 demonstrates that claims 1-16 were anticipated by, or obvious over Carlson (EX1005), one of Patent Owner's own patent applications. The '363 patent impermissibly attempts to claim the same technology (or obvious variants thereof) that Patent Owner disclosed years earlier in Carlson.

Ground 2 demonstrates that claims 1-14 were obvious over Ghaly and Heddebaut (EX1009). Ghaly does not disclose a particular technology for determining a train's position and speed in its decentralized train-control system, leaving that choice to POSAs. Heddebaut, in turn, discloses using UWB radios to determine train position and speed via UWB-ranging. As Ground 2 demonstrates, POSAs had reason to use Heddebaut's UWB radios in Ghaly's system, rendering claims 1-14 obvious.

Grounds 3 and 4 demonstrate how the challenged claims were obvious even under an alternate narrow claim construction that Patent Owner may pursue. Specifically, Patent Owner may argue the claimed system requires a train-mounted UWB-radio ranging with a selected subset of nearby UWB-radios rather than ranging with all nearby radios. Although that system is not described in the '363 patent, it nonetheless would have been obvious over Carlson (Ground 3) and/or Ghaly-Heddebaut (Ground 4) in view of Gantner, which discloses ranging with a subset of responding UWB-radios.

III. CERTIFICATION OF STANDING

The '363 patent is available for IPR, and Petitioners are not barred or estopped from requesting this IPR. 37 C.F.R. §42.104(a).

IV. UNPATENTABILITY GROUNDS

Petitioners request cancellation of claims 1-16 as follows.

Ground	Reference(s)	Claim(s)	Basis
1	Carlson	1-16	102/103
2	Ghaly, Heddebaut	1-14	103
3	Carlson, Gantner	1-16	103
4	Ghaly, Heddebaut, Gantner	1-14	103

The above-identified references are prior art (at least) under post-AIA §102(a)(1) based on the following publication dates, each of which is more than one year before the earliest-alleged priority date (August 4, 2017):

Reference	Publication Date
Carlson	2015-11-19
Gantner	2009-10-08
Ghaly	2016-02-24
Heddebaut	2006-07-13

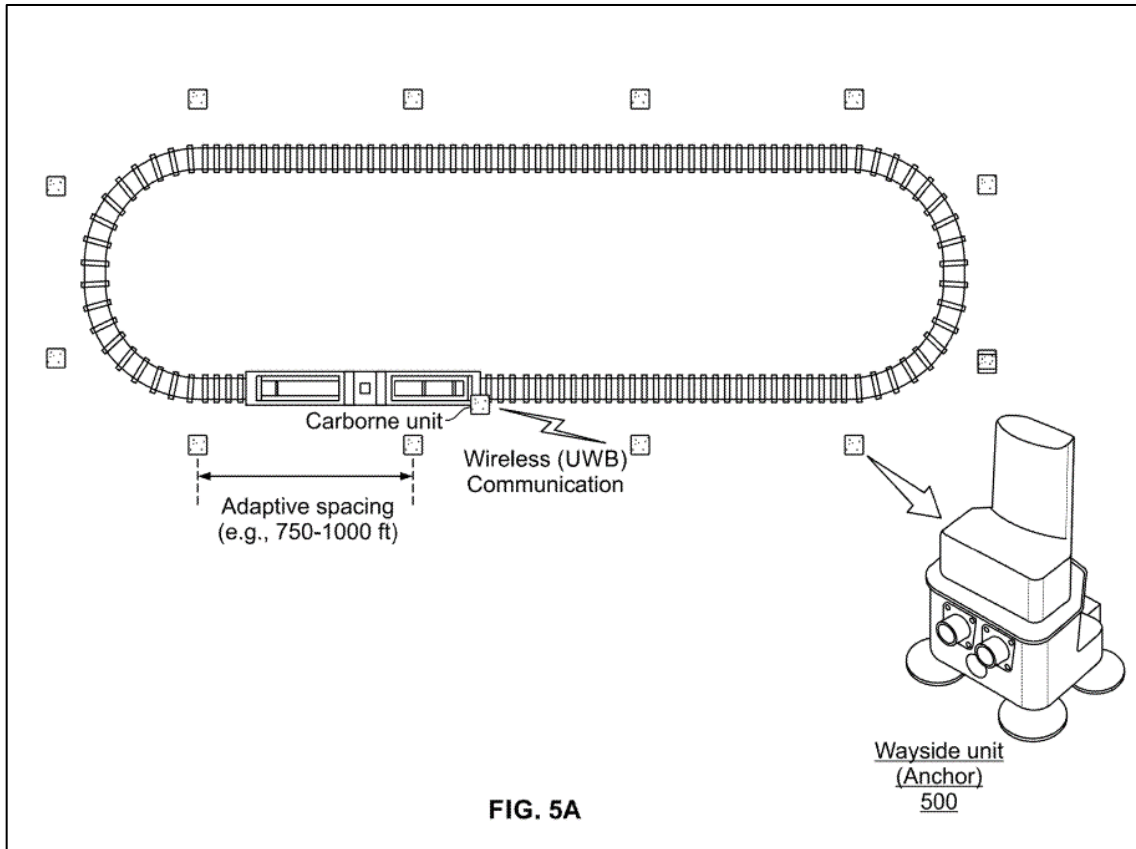
Only Carlson and Heddebaut were cited during prosecution, but neither was cited in a rejection.

V. THE '363 PATENT²

The '363 patent discloses a system for “decentralized rail signaling and positive train control.” 1:21-25. According to the patent, conventional train-control systems relied on a “centralized entity” to control train signaling and movement. 3:5-24, 4:13-24; EX1003 (“Kain-Decl.”), ¶¶45-46. Rather than rely on a centralized entity, the system is “train centric,” allowing certain train-control functionality to be performed on the train itself. 3:34-47; Kain-Decl., ¶47, ¶¶27-34 (overview of prior-art decentralized-train control systems).

The patent’s “train-centric” system includes train-mounted “carborne units” and “wayside units” installed on “structures near the tracks, such as tunnel walls [or] signal posts.” 4:25-31, 4:43-51, FIG. 1. The units communicate with one another using UWB radios. 4:19-24, 4:42-60, 6:7-24, 7:57-8:23; Kain-Decl., ¶¶48-49, ¶¶35-44 (overview of UWB). Figure 5A (below) illustrates an exemplary deployment of wayside units (a.k.a. “anchors”) communicating with a carborne unit via UWB:

² Unless otherwise noted, Section V’s citations are to EX1001.



A train determines its “position and speed” by “ranging with UWB anchors.”

10:3-5. With UWB-based ranging, “the range [*i.e.*, distance] between a UWB transmitter and receiver [is] calculated as the time of flight [of UWB signals] between the transmitter and the receiver (one way) multiplied by the speed of light.”

13:64-14:8; Kain-Decl., ¶¶50-52, ¶¶35-44 (overview of UWB-ranging). As trains pass wayside-anchors, trains determine their “absolute location by the ID number of the anchor and referencing the distance to that anchor with [an] on-board track map.”

10:3-11. Trains may also determine speed and direction using UWB-based ranging.

Id.

Using its UWB-determined location, direction, and/or speed, a train's onboard computer system can implement various functions. 19:39-53. For example, it can regulate its speed or engage an auto-braking system if the distance to another object (*e.g.*, another train) is too close. 17:15-28, 17:44-48, 19:39-53.

In addition to using UWB signaling to determine location, direction, and/or speed, the patent says the system can use other conventional "sensing technologies," like RFID or GPS. 5:37-65, 17:29-37, FIG. 8; Kain-Decl., ¶¶54-55. Although "decentralized" and "train-centric," the system includes centralized components like a "central server" or an "automatic train supervision" system that sends messages/requests directly (or indirectly) to trains. 4:48-60, 19:24-30, 24:25-28, FIG. 10; Kain-Decl., ¶56 (explaining system is "mostly" decentralized but includes some centralized components too).

A. Challenged Claims

Claims 1-16 are reproduced in the Claim Listing. *Infra* §IX.

Independent claim 1 recites a "system for providing decentralized control operations" including (1) "a plurality of wayside units" and (2) "one or more train-mounted units." Each train-mounted unit communicates with other train-mounted units and/or wayside units using UWB-based signals and "generate[s] based on the [UWB] communication, control information configured for use in controlling one or more function of the train."

The claim limits the “control information” to information that “comprises or is based on obtaining ranging measurements,” and further limits how the train-mounted unit obtains ranging measurements to:

1. broadcasting UWB-based signals within a wireless range of the train-mounted unit, the UWB-based signals comprising information identifying the train-mounted unit,
2. selecting based on received responses to the broadcast UWB-based signals, one or more of the plurality of wayside units; and
3. determining ranging information corresponding to each of the one or more wayside units, based on UWB-based signals communicated respectively with each of the one or more of the plurality of wayside units.

Some of the dependent claims further limit the claimed system to ones that also use conventional technologies like RFID or GPS. *E.g.*, claims 2, 5-8. Others limit how the train-mounted unit controls the train’s functions. *E.g.*, claims 3-4. These and other conventional features in the dependent claims were in the prior art. Kain-Decl., ¶¶59-62.

B. Level of Ordinary Skill in the Art

POSAs 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. Kain-Decl., ¶¶21-24.

C. Prosecution History

The application that became the '363 patent was filed on July 18, 2019. EX1002, 2-75, 565. The as-filed claims were rejected as anticipated by U.S. Patent Appl. No. 2013/0138276 (EX1013; "Soderi") or obvious over Soderi in view of U.S. Patent No. 9,434,397 (EX1014; "Chung"). EX1002, 583-591.

The claims were ultimately allowed when claim 1 was amended to limit how the train-mounted unit obtains ranging measurements to the "broadcasting," "selecting," and "determining" steps discussed above. EX1002, 719-730, 750-754.

VI. CLAIM INTERPRETATION

Claim limitations are construed according to their ordinary meaning in light of the specification and prosecution history. 37 C.F.R. §42.100(b). Because the prior art plainly discloses the claim limitations, no express constructions are necessary. *Vivid Techs. v. Am. Sci. & Eng'g*, 200 F3d 795, 803 (Fed. Cir. 1999).

VII. GROUNDS FOR UNPATENTABILITY

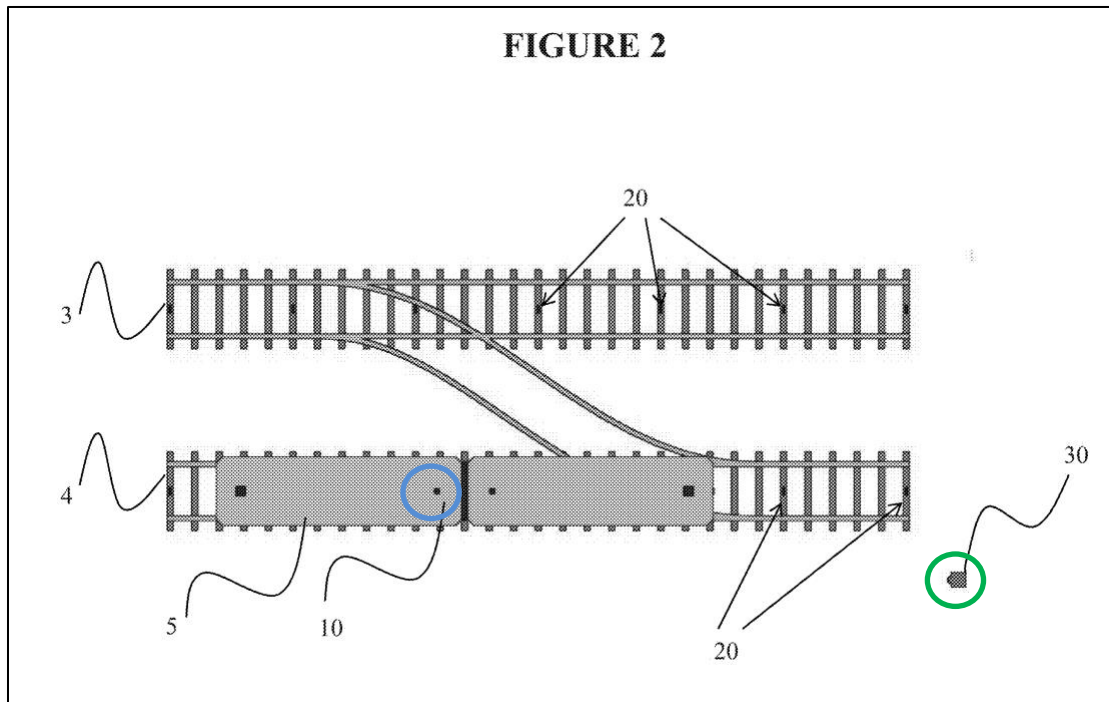
A. Ground 1: Claims 1-16 Are Anticipated by and/or Obvious Over Carlson

1. Carlson (EX1005)³

Carlson discloses a decentralized “rail vehicle control system” ([0009]) that allows trains to “operate autonomously and make internal operational decisions without requiring a central server” ([0122]); Kain-Decl., ¶¶62-64. Carlson’s system includes two primary components: (1) a train-mounted “vehicle mounted control system (‘VMCS’)” ([0050]) and (2) “one or more reporting stations” located along a railroad “at strategic wayside locations” (e.g., at signaling stations) ([0051], [0122]). The train-mounted VMCS uses UWB and time-of-flight techniques to determine a distance to another train-mounted VMCS or a wayside-located reporting station. Abstract, [0013], [0015]; Kain-Decl., ¶¶65-67.

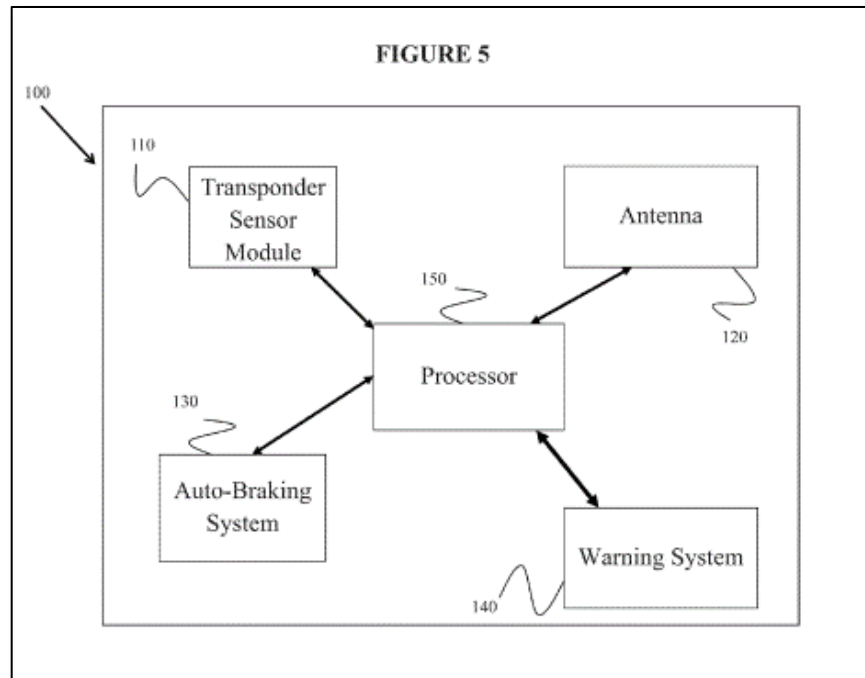
Figure 2 (below) illustrates an exemplary train-mounted VMCS 10 (blue) and reporting station 30 (green) near the track ([0055]-[0057]):

³ Unless otherwise noted, Section VII.A’s citations are to Carlson.



VMCS 10 includes four components—a collision-avoidance system, an RFID reader, a data-collection system, and a supervisory component. [0062]-[0063]; FIG. 4; Kain-Decl., ¶¶68-69. These components are “mounted, connected, or otherwise installed on a rail vehicle,” and the entire VMCS 10 is either a single module installed on the train or multiple modules installed at different locations on the train. [0062].

The VMCS 10’s “collision avoidance system” includes five sub-components (shown below): a transponder sensor module, antenna, auto-braking system, warning system, and processor. [0064]-[0065]; Kain-Decl., ¶¶70-71.

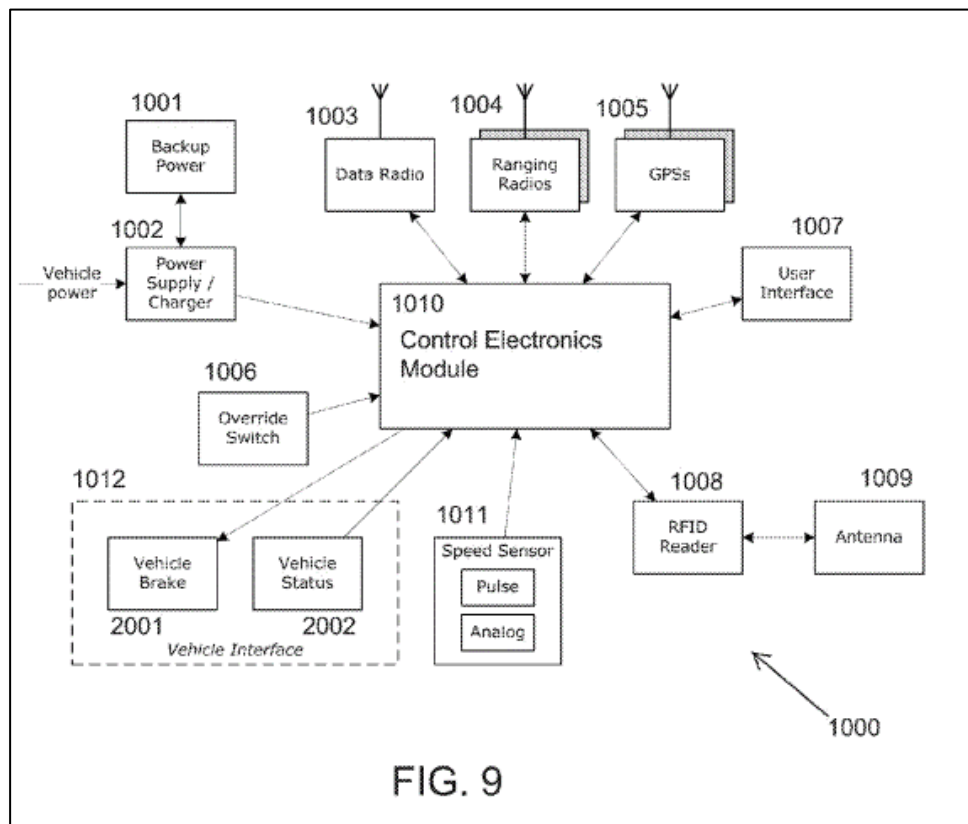


The transponder sensor module communicates with transponders in other train-mounted VMCS modules and/or reporting stations to determine the distance between the transponders. [0067]-[0070]. Although the transponders can use various ranging technologies, Carlson primarily discloses using “a UWB ranging unit.” [0067]; Kain-Decl., ¶¶71-72. Using UWB signals to perform a “time of flight” technique, VMCS 10 determines the distance between its UWB-transponder and a companion UWB-transponder “based on the time it takes a signal to travel between the transponder sensor modules.” [0068], [0072]; Kain-Decl., ¶¶72-73.

For redundancy and improved accuracy, VMCS 10 also determines its absolute position and speed using GPS ([0071]-[0074]) and/or communications with RFID tags on the track ([0054]-[0056]); Kain-Decl., ¶¶74-77.

Based on the positional and speed information it obtains, VMCS 10 determines whether an unsafe condition exists, *e.g.*, whether the distance to another vehicle or a reporting station is below a threshold. [0016], [0118], FIG. 8 (steps 810-820). VMCS 10 will then generate alerts to the vehicle operator, like “an audible tone” or “a visual indication.” [0047], [0080]-[0081], FIG. 8 (step 840). If the vehicle operator does not take corrective action, VMCS 10 initiates its auto-braking system. [0040], [0076]-[0079], FIG. 8 (steps 850-860); Kain-Decl., ¶¶78-83.

Carlson’s Figure 9 (below) illustrates VMCS 1000, which is “similar to VMCS 10” and which, like VMCS 1000, can “be adapted to perform” Carlson’s “techniques.” [0127]; Kain-Decl., ¶¶84-85.



Like VMCS 10, VMCS 1000 uses UWB signals “to determin[e] range information” and “communicate data, such as[,] the VMCS’s unique ID.” [0132]; [0051]; [0091]; Kain-Decl., ¶¶86-88.

2. Claim 1

a. [1PRE]: “A system for providing decentralized control operations in a railway network”

Claim 1’s preamble is not limiting because the claim’s body “defines a structurally complete invention” and the preamble relates only to a “purpose or intended use of the invention.” *Rowe v. Dror*, 112 F.3d 473, 478 (Fed. Cir. 1997). Regardless, if limiting, Carlson discloses it.

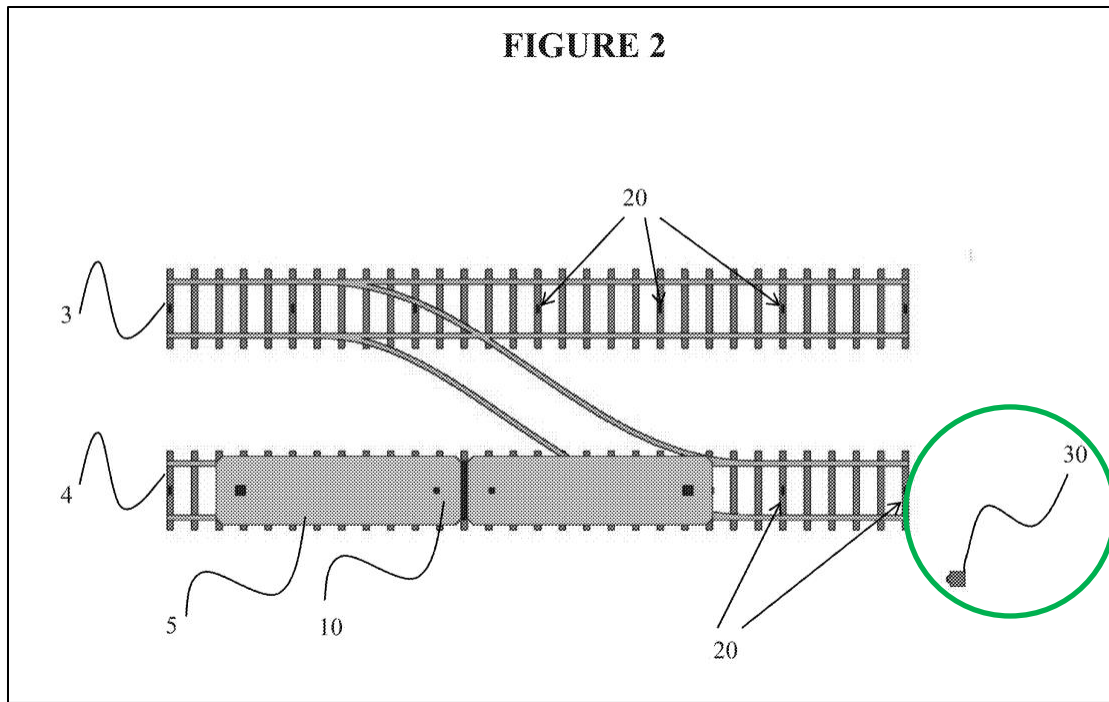
The ’363 patent describes, and POSAs would have understood, “*decentralized control operations*” as control operations that trains execute on their own without reliance on a separate centralized entity. EX1001, 4:12-19; Kain-Decl., ¶¶89-90. A system provides “*decentralized control operations*,” even if some centralized entity is present and involved in train control, so long as certain train-control operations, *e.g.*, speed regulation, are performed autonomously by the train. Kain-Decl., ¶¶94-98 (explaining patent’s “decentralized” system nonetheless includes “centralized” components like a “central server”); *see also infra* claim 12.

Carlson discloses a system for “*decentralized control operations in a railway network*,” as claimed. Specifically, Carlson discloses a “**control system**” for “a **rail**

network” ([0010]), and “[t]he vehicle-side portion of the system can operate **autonomously** and make internal operational decisions **without requiring a central server**” ([0122]). “Such a **decentralized** approach may allow each vehicle to determine its safe operating envelope using only the necessary local inputs from signals and other vehicles.” [0126]; *see also* [0077]-[0078] (describing autonomous “auto-braking”); Kain-Decl., ¶¶92-94, ¶¶99-100.

b. [1A]: “a plurality of wayside units, each configured for placement on or near tracks in the railway network”

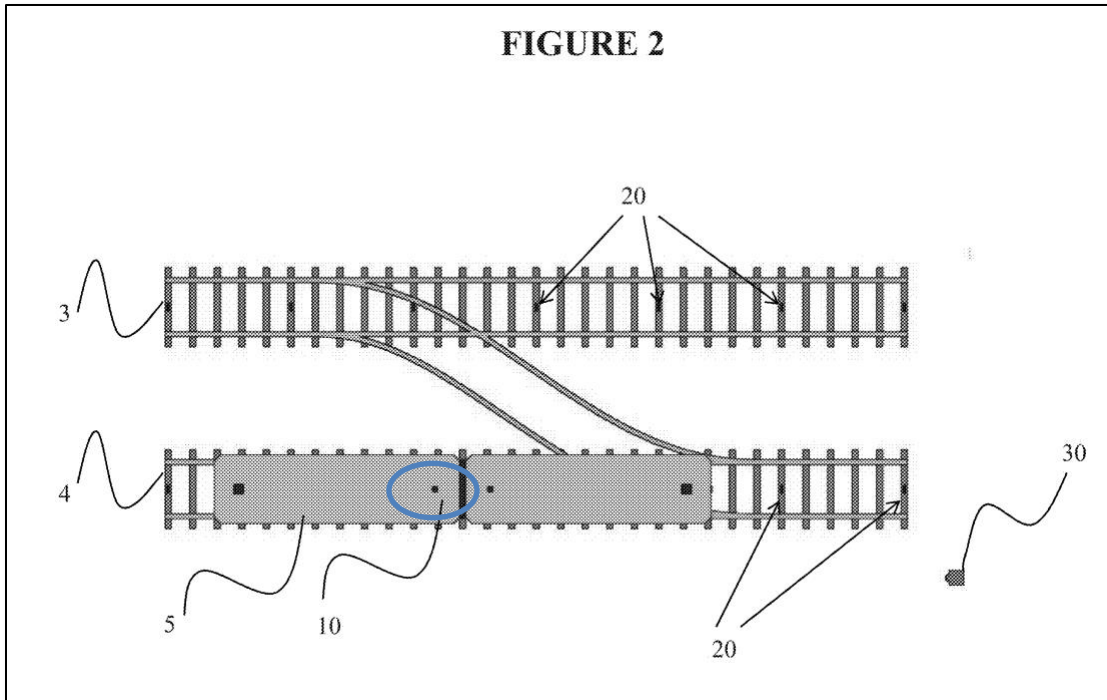
Carlson’s system includes “one or more reporting stations 30” (green below), which are wayside units “positioned at fixed positions **along a railroad track.**” [0051], [0057], [0122] (“multiple sensing and communication technologies which are mounted...at strategic **wayside locations**”); Kain-Decl., ¶¶101-106; EX1001, 14:39-42 (“wayside devices” are “installed along the track”), FIG. 5A.



A reporting station can also be “integrated” with a “signal control point” ([0058], FIG. 3) “located along the railroad track” ([0010], [0032], [0040], [0051]). Kain-Decl., ¶102, ¶¶107-108; EX1001, 4:48-51.

c. [1B]: “one or more train-mounted units, each configured for deployment on a train operating in the railway network”

Carlson’s system includes one or more “**vehicle mounted** control system (‘VMCS’) 10” modules (blue below), “mounted or installed on...a train.” [0050]; [0062]-[0066]; FIG. 2; Kain-Decl., ¶¶109-112.



d. [1C]: “wherein each train-mounted unit is configured to:

- (1) [1C1]: “communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals”

Each VMCS 10 is configured to communicate with any reporting/signaling station (*i.e.*, “wayside unit,” *supra* limitation 1A) or other train-mounted VMCS (*i.e.*, “train-mounted unit,” *supra* limitation 1B) that comes within communication range. [0067] (“transponder sensor module [in the VMCS]...communicate[s] with other transponder sensor modules installed on proximate rail vehicles”), [0091] (“when the rail vehicle passes a reporting station...VMCS 10 can communicate information

to the report station”); *see also* [0009], [0015], [0050]-[0051], [0062]-[0064], FIGS. 1-2; Kain-Decl., ¶¶113-114.

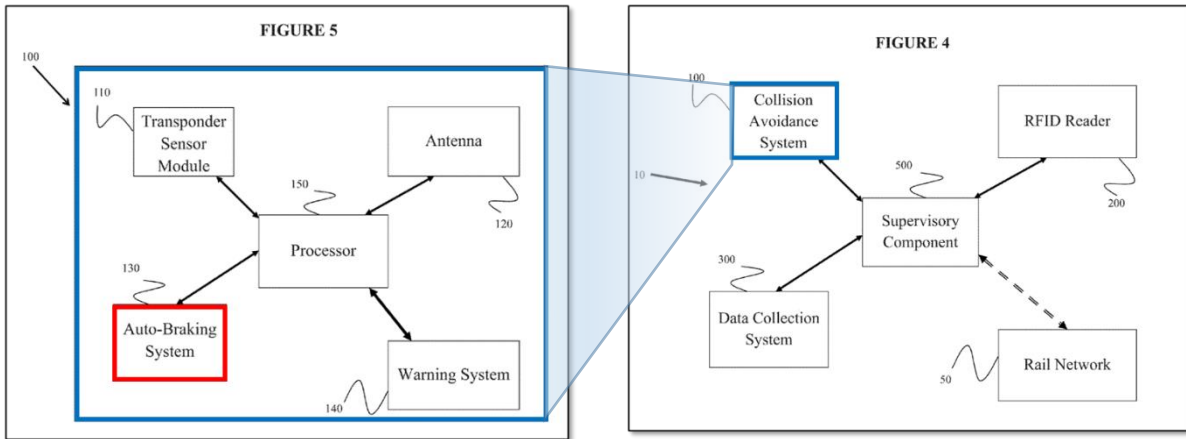
Each train-mounted VMCS and wayside-located reporting/signaling station “communicate[s] with each other through [] UWB components,” which send and receive UWB-based signals. Abstract, [0013], [0038], [0040], [0051], [0067], [0074], [0132], claim 7; Kain-Decl., ¶¶115-116.

If Carlson is found not to disclose that VMCS 10 communicates with “*any*” reporting/signal station or train-mounted VMCS 10 within range, then POSAs had reason to implement VMCS 10 in that manner. As discussed *infra* limitation 1C2, VMCS 10 communicates with other system devices to make vehicle-control decisions based on, e.g., the vehicle’s distance to reporting/signal stations and/or other train-mounted VMCS 10 modules. [0076]-[0082]. Having a VMCS 10 module communicate with *any* reporting/signal station(s) or VMCS 10 module within range would have better ensured that VMCS 10 received all potentially relevant data, *e.g.*, to detect more potential collisions. Kain-Decl., ¶¶117-118.

- (2) **[1C2]: “generate based on the communication, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network,”**

VMCS 10 includes a collision-avoidance system with “an auto-braking system.” [0063], [0065], FIGS. 4-5 (annotated below). VMCS 10 uses its auto-

braking system to “control[] one or more functions of the train in conjunction with operation in the railway network,” as claimed. Kain-Decl., ¶¶119-120.



For example, if VMCS 10 determines that the distance to another train-mounted VMCS “violate[s] a pre-set separation distance,” then VMCS 10 will “initiate an auto-brake function to slow the offending vehicle or vehicles in order to maintain a safe distance.” [0040]; *see also* [0076] (distance determination used to “initiate the auto-braking feature”), [0093], [0118], claim 9 (“train-mounted subsystem” configured to “cause the braking system of the vehicle to activate” based on distance determination); Kain-Decl., ¶¶121-122.

VMCS 10’s auto-braking system can also “automatically brake...based on the distance between the vehicle and a signal control point.” [0077]; *see also* [0082], claim 9; Kain-Decl., ¶123.

VMCS 10 determines whether to initiate auto-braking using distance determinations it generates based on UWB communications with either (1) other

train-mounted VMCS modules and/or (2) wayside-located reporting/signal stations. [0012], [0015] (“determine[s] a distance” based on “communication between the UWB communications component[s]”), [0040] (“UWB system” used to “determine a distance” to “another rail vehicle or signal control point”), [0067]-[0068], [0074] (“UWB communications” determines “distance” to reporting stations); claims 1, 7; Kain-Decl., ¶124; *supra* limitation 1E.

The UWB-derived distance determinations that VMCS 10 generates and/or information it generates based on those determinations to initiate/control its auto-braking system are “*control information*” that are “*generated based on the [UWB] communication*” between VMCS 10 and other train-mounted VMCS modules and/or wayside-located reporting/signal stations, as claimed. Kain-Decl., ¶¶125-126.

e. [1D] “wherein generating the control information comprises or is based on obtaining ranging measurements”

The distance determinations that VMCS 10 generates and/or the information it generates based on those determinations to initiate/control its auto-braking system (i.e., “*control information*”) “*comprises or is based on obtaining ranging measurements*,” as claimed. Kain-Decl., ¶¶127-128.

For example, the distance between VMCS 10’s UWB transponder and a UWB transponder on either another train-mounted VMCS or a reporting/signal station is measured “based on the time it takes a [UWB] signal to travel between the

transponder sensor modules,” so-called “time-of-flight” (a ranging measurement). [0068]; Kain-Decl., ¶¶129-130; *see also* Abstract (UWB used to measure distances based on “time-of-flight”), [0013] (same), [0015] (same), [0038] (UWB is a “**ranging** technology”), [0041] (similar), [0067] (“UWB **ranging** unit”), [0131] (“**ranging** radio” is “ranging” because it may “determine a distance” using “time-of-flight” techniques), [0132], claim 7.

f. [1E]: “wherein obtaining the ranging measurements comprises:

(1) [1E1]: “broadcasting ultra-wideband (UWB) based signals within a wireless range of the train-mounted unit...”

As explained *supra* §§VII.A.2.d-VII.A.2.e (limitations 1C-1D), VMCS 10 “include[s] a **UWB ranging unit** configured to send UWB radio waves” to other UWB-enabled transponders within wireless range of the VMCS, *e.g.*, transponders on another train-mounted VMCS modules or on wayside-located reporting/signal stations. [0067]; *see also* [0013], [0040]-[0041], [0057], [0065]-[0068], FIGS. 1, 4-5, 8; Kain-Decl., ¶131, ¶135.

POSAs understand that VMCS 10 transmits UWB signals using a broadcast (*i.e.*, one-to-many) technique because the signals are communicated to multiple UWB-enabled transponders simultaneously. [0064] (explaining VMCS 10 “determine[s] a distance between the rail vehicle and the proximate rails **vehicles** [plural] on the same track”); Kain-Decl., ¶¶132-136 (describing the broadcast

transmission technique for UWB-based communications, including for time-of-flight-based ranging); EX1017 (defining “broadcast” as “to communicate or transmit...to numerous recipients simultaneously”); EX1027 (similar); EX1028 (similar); *see also* EX1023, [0003]-[0004].

If Carlson is found not to disclose that VMCS 10 broadcasts UWB signals, POSAs had reason to do so. POSAs understood VMCS 10 would have sometimes been unaware of all reporting/signal stations and/or other VMCSs within its wireless range. Kain-Decl., ¶137. This would have occurred, for example, (i) when VMCS 10 was initialized/restarted and (ii) when a reporting station or another vehicle first comes into range (*e.g.*, from around a curve). Kain-Decl., ¶137. Broadcasting UWB ranging signals, rather than addressing them to individual transponders, would have better ensured that VMCS 10 identified and received responses from ***all*** wayside reporting stations and train-mounted VMCSs within communication range, not just those already known to the VMCS. Kain-Decl., ¶138. Broadcasting UWB signals would thus have advanced Carlson’s goal of reducing vehicle collisions by better ensuring detection of all reporting/signal stations and VMCS-equipped vehicles within wireless range. Kain-Decl., ¶138. Broadcasting UWB-based signals for ranging purposes was also conventional by the mid-2010s, and thus POSAs would have had a reasonable expectation of success in modifying VMCS 10 to broadcast

such signals. Kain-Decl., ¶¶139-140 (citing EX1019, 146-147; EX1021, [0076]-[0077]).

(2) [1E2]: “the UWB based signals comprising information identifying the train-mounted unit”

In describing VMCS 1000 (which is “similar to” VMCS 10), Carlson says the UWB signals it transmits include information beyond “range information,” like the VMCS’s “unique ID.” [0127], [0132]. POSAs understood that VMCS 10 likewise included its “unique ID” when broadcasting UWB signals. Kain-Decl., ¶¶141-142.

For example, train-mounted VMCSs “exchange data and information” with reporting stations ([0051]), which then relay that information to a rail network that “manages and maintains information relating to the speed and location of” trains in the system ([0052]). For the reporting stations to properly associate the exchanged “data and information” with the VMCS 10 in the system that sent the data and thus allow the rail network to track individual trains, POSAs understood that each VMCS 10’s broadcasted UWB signals—like VMCS 1000’s UWB signals—include a unique ID identifying the VMCS. Kain-Decl., ¶143.

If Carlson is found not to disclose that the UWB signals VMCS 10 broadcasts include information identifying VMCS 10, POSAs had reason to implement Carlson’s VMCS 10 to broadcast UWB signals with information identifying it as the source of the signal.

First, as discussed above, Carlson teaches that VMCSs and reporting stations “exchange data and information” ([0051]), which the rail network uses to track trains ([0052]). Carlson also teaches that one piece of data exchanged via UWB signaling includes the “unique ID” of the device transmitting the UWB signal. [0127], [0132]. Including the VMCS’s unique ID in UWB-based signals broadcast by the VMCS would have therefore facilitated Carlson’s goal of tracking vehicles in the network and been consistent with the type of data that Carlson explicitly taught was exchanged via UWB signaling. Kain-Decl., ¶¶144-145.

Second, ranging requires VMCS 10 to receive a “responsive signal from a corresponding transponder sensor module.” [0067], [0068] (“distance between the various transponder sensor modules...can be determined [b]y measuring...**a precisely timed response**”). However, the corresponding transponder sensor module (in another VMCS or reporting station) would have sometimes received ranging signals from multiple VMCSs close together in time (*e.g.*, from another VMCS on the same vehicle or from VMCSs on other, nearby vehicles). [0050] (disclosing that one vehicle may have multiple VMCSs); Kain-Decl., ¶146. To ensure proper ranging calculations at each VMCS, POSAs would have wanted responsive signals to identify the VMCS being responded to, *i.e.*, the VMCS that sent the original transmission. Thus, POSAs had reason to include VMCS 10’s unique ID in the broadcast signal to enable the responding transponder to include

that unique ID in its response. Kain-Decl., ¶¶147-149 (citing, *e.g.*, EX1020, [0028]; EX1021, [0074]-[0075] (UWB-based ranging broadcasts and responses), FIG. 4 (“Destination Address”; “Source Address”); EX1022, [0069]).

Third, including a source address—*i.e.*, a unique identifier for the transponder sending a UWB signal—was a standardized technique for UWB signaling. Kain-Decl., ¶150. The IEEE 802.15.4-2011 standard standardized the MAC frame for UWB signals, which includes a “Source Address” uniquely identifying the transponder. EX1019, 40-41, 57-59; Kain-Decl., ¶150. Including information identifying the transmitting VMCS 10 would therefore have been routine implementation of the then-standardized UWB MAC frame. Kain-Decl., ¶151.

As the IEEE standard reinforces, including information identifying the transponder that sends a UWB signal was conventional by the mid-2010s, and thus POSAs would have had a reasonable expectation of success in modifying VMCS 10 to broadcast such signals. Kain-Decl., ¶¶151-152.

(3) [1E3]: “selecting based on received responses to the broadcast UWB based signals, one or more of the plurality of wayside units; and

Although it does not use the term “selecting,” the ’363 patent describes one embodiment where a train-mounted unit broadcasts UWB-based signals to a plurality of wayside units (*i.e.*, anchors) and receives responses from the wayside units. Kain-Decl., ¶¶153-154. In that embodiment, a train-mounted unit “send[s] a

broadcast UWB message for all UWB devices (*e.g.*, PTCS-anchors) within its wireless range, to announce its presence and identification information.” EX1001, 15:31-35. “Once the UWB responses from the UWB devices (*e.g.*, anchors) are received, the [] carborne unit commences an individual range measurement with each responding UWB device.” EX1001, 15:35-39. The **initial** UWB responses the carborne unit receives “include a range measurement,” which permits the carborne unit to determine its distance from the responding device(s). EX1001, 15:42-50.

In light of the specification, POSAs understand limitation 1E3 covers a train-mounted unit configured for “selecting” one or more wayside units by receiving responses from those wayside units that responded to its original broadcast signal. Kain-Decl., ¶155. Stated differently, there is no support in the specification to interpret “selecting” to require the train-mounted unit to pick a subset of responding wayside units.⁴ Kain-Decl., ¶155.

Carlson’s VMCS 10 selects wayside units like the carborne unit does in the above-described embodiment. As discussed *supra* limitation [1E4], to perform a ranging measurement, VMCS 10 receives responsive signals from the wayside

⁴ Grounds 3 and 4 demonstrates how the challenged claims would still be obvious even if patent owner were to argue that [1E3]’s “selecting” requires picking a subset of responding devices and determining ranging information for only that subset.

reporting/signal stations that received the broadcast signal(s) transmitted by VMCS 10. [0067]-[0068]; Kain-Decl., ¶156. When VMCS 10 obtains a ranging measurement based on the responsive signal(s), VMCS 10 has selected the reporting/signal station(s) in the same way the '363 patent selects wayside units. Kain-Decl., ¶¶156-157.

- (4) **[1E4]: “determining ranging information corresponding to each of the one or more wayside units, based on ultra-wideband (UWB) based signals communicated respectively with each of the one or more of the plurality of wayside units.”**

As discussed *supra* §VII.A.2.d (limitation [1C]), VMCS 10 includes “a UWB ranging unit configured to send UWB radio waves.” [0067]. The ranging unit “detect[s] the distance...between a rail vehicle and signal/reporting station based on the time it takes a [UWB-based] signal to travel between the transponder sensor modules.” [0068]; *see also* claim 1 (“determine a distance...based on a time-of-flight” of UWB-signals), claim 7 (same). Thus, Carlson’s VMCS 10 determines ranging information (*e.g.*, distance) to wayside signal/reporting stations based on the UWB-based signals it communicates with wayside signal/reporting stations, as claimed. Kain-Decl., ¶¶158-160.

3. Claim 2: “The system of claim 1, wherein the train-mounted unit is configured to generate at least part of the control information based on sources other than processing of the ultra-wideband (UWB) based signals.”

As discussed *supra* §VII.A.2.d(2) (limitation [1C2]), VMCS 10’s collision-avoidance system (1) generates distance determinations (*e.g.*, distance to another VMCS 10 or a reporting station) based on processing of UWB-based signals and (2) uses those distance determinations to control the train’s movement (*e.g.*, stop/slow the train if the distance is below a threshold). Kain-Decl., ¶¶161-162.

In addition to being based on processing UWB-based signals, Carlson’s distance determinations (*i.e.*, “*control information*,” as claimed, *supra* §VII.A.2.d(2) (limitation 1C2)) are also determined by processing non-UWB-based signals. For example, Carlson discloses that VMCS 10 also determines distances based on GPS-position information, “used in combination with” the “time of flight” technology (*e.g.*, UWB-based ranging), “to determine a separation distance.” [0071]; Kain-Decl., ¶163.

VMCS 10 is therefore configured to generate at least part of the distance determinations (*i.e.*, “*control information*,” as claimed) based on sources other than processing UWB-based signals, *e.g.*, GPS signals, as claimed. Kain-Decl., ¶164.

4. Claim 3

- a. [3A]: “The system of claim 2, wherein the train-mounted unit is configured to assess based on the processing of the ultra-wideband (UWB) based signals, one or more conditions relating to operation of the train within the railway network”

As discussed *supra* §§ VII.A.2.d(2) & VII.A.3 (limitation [1C2] and claim 2), VMCS 10 (using its collision-avoidance system) processes UWB-based signals to determine the distance to either another VMCS or reporting station(s). This distance determination is a “*condition relating to operation of the train within the railway network*,” as claimed. Kain-Decl., ¶¶165-166.

In addition to determining distance separations, VMCS 10 also processes UWB signals to determine other “*conditions relating to operation of the train within the railway network*,” as claimed. For example, VMCS 10 processes UWB signals to determine the ***absolute position*** and/or ***speed*** of the vehicle on which the VMCS is mounted. [0071] (UWB signals used, in part, to calculate absolute position of the vehicle), [0072] (“measure speed using the UWB time-of-flight data”), [0090]. Kain-Decl., ¶167.

The absolute position and speed of the vehicle on which the VMCS is mounted and its distance from other vehicles or reporting/signal stations within the railway network are all “*conditions relating to operation of the train within the*

railway network” that are assessed by the processing of UWB-based signals, as claimed. Kain-Decl., ¶168.

- b. [3B]-[3C]: “when at least one condition meets one or more particular criteria, determine one or more responsive actions and perform or cause performing each of the one or more responsive actions.”**

VMCS 10 initiates its auto-braking system and/or warning system (FIG. 5), when it determines one of the conditions the VMCS assesses based on the processing of UWB-based signals (*i.e.*, absolute position, speed, or separation distance) meets a particular criterion. Kain-Decl., ¶169.

For example, when the VMCS determines that the separation distance to either (1) another VMCS or (2) a reporting station “has come within a predetermined limit,” the VMCS “initiate[s] the auto-braking feature.” [0076], [0082] (describing auto-braking function). Similarly, when the separation distance comes within a predetermined limit, the train-mounted VMCS warns the train operator (*e.g.*, via audio or visual indicators). [0035] (“warn the operator...when the distance between vehicles has breached an acceptably safe value”), [0080]-[0081] (“warning system...can generate an audible and/or visual warning”); Kain-Decl., ¶170.

Likewise, when the VMCS determines the vehicle’s speed exceeds a predetermined limit, the VMCS can automatically brake the train and/or issue a warning to the operator. [0036] (when the train is speeding, the system “can effectively warn

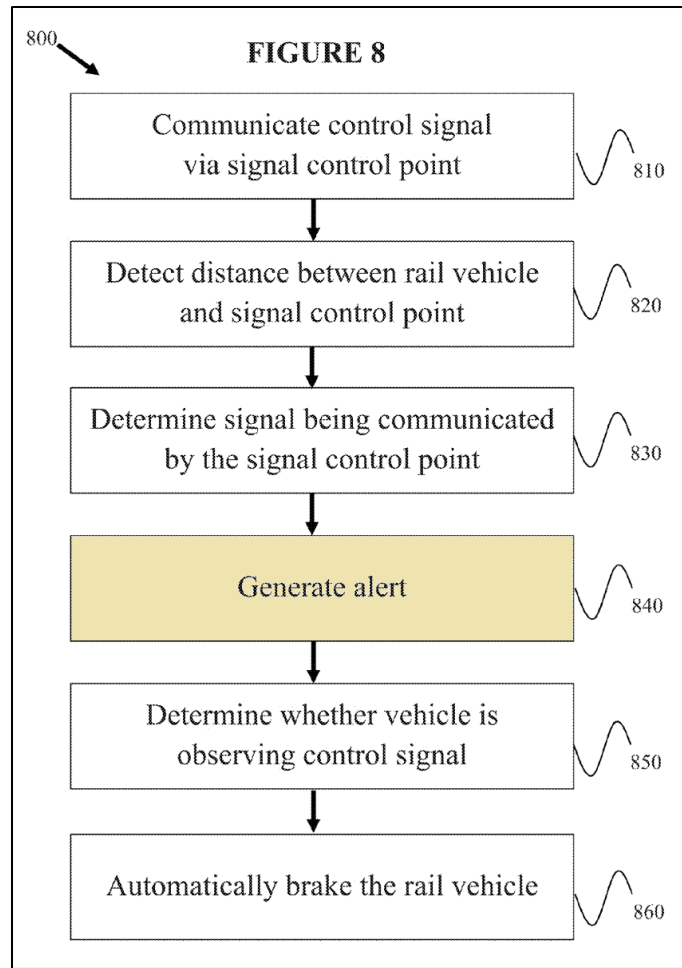
the operator, automatically brake the rail vehicle, or otherwise control the rail vehicle”), [0117]-[0118]; Kain-Decl., ¶171.

Initiating the auto-braking or warning system is a “*responsive action*” that VMCS 10 determines should be performed based “*when at least one condition*” discussed with respect to limitation 3A, *i.e.*, distance and/or speed, “*meets one or more particular criteria,*” *e.g.*, too close or too fast. Kain-Decl., ¶172.

5. Claim 4

- a. **[4A]: “The system of claim 3, wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator”**

As discussed above for limitation 3B, one responsive action the train-mounted VMCS performs is “generat[ing] a warning signal,” *e.g.*, “beeps or alarms that will continue until the vehicle operator acknowledges the signal.” [0112], FIG. 8 (step 840), claim 2 (“generate an alert”). The warning signal for the train operator relates to at least one of the conditions discussed above, *e.g.*, (1) the distance to another VMCS or a reporting/signal station being below a threshold or (2) the train exceeding a speed limit. [0080]-[0081], [0117]; Kain-Decl., ¶173.

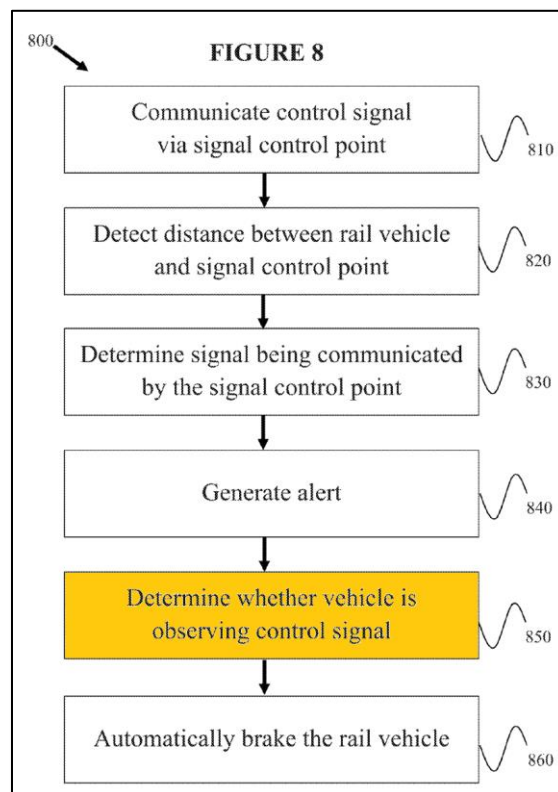


b. [4B]: “the train-mounted unit is configured to: monitor actions of the train operator”

VMCS 10’s collision-avoidance system “*monitors actions of the train operator,*” as claimed. For example, it monitors whether the operator has “decreased the [train’s] speed” or stopped the train. [0081], [0112], FIG. 8 (step 850); Kain-Decl., ¶174.

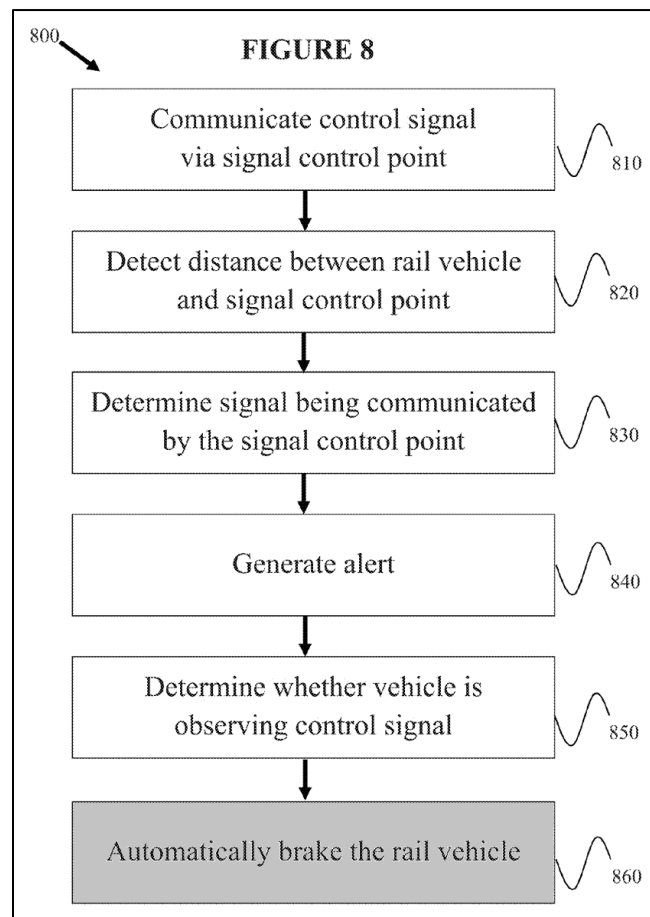
- c. **[4C]: “assess based on the monitoring, the train operator’s compliance with at least one expected subsequent responsive action”**

VMCS 10’s collision-avoidance system assesses whether “the condition that originally caused the alarm has been cleared” by the train operator’s compliance with at least one expected responsive action. [0081]-[0082], FIG. 8 (step 850), [0112] (assessing whether operator has “take[n] steps to slow and/or stop the vehicle”). For example, VMCS 10 assesses whether the operator has taken responsive action and started “braking within a predetermined distance or time.” [0082]; *see also* [0076] (discussing signal compliance); Kain-Decl., ¶¶175-176.



- d. [4D]: “when the train operator fails to do so, directly perform the at least one expected subsequent responsive action or perform an alternative action.”

When VMCS 10’s collision-avoidance system determines the operator has failed to take sufficiently corrective/responsive action, VMCS 10 directly performs the expected corrective/responsive action, *e.g.*, “slow or bring the vehicle to a halt.” [0082], [0076] (“initiate the auto-braking feature”), [0113]-[0114], [0118], FIG. 8 (step 860); Kain-Decl., ¶¶177-178.



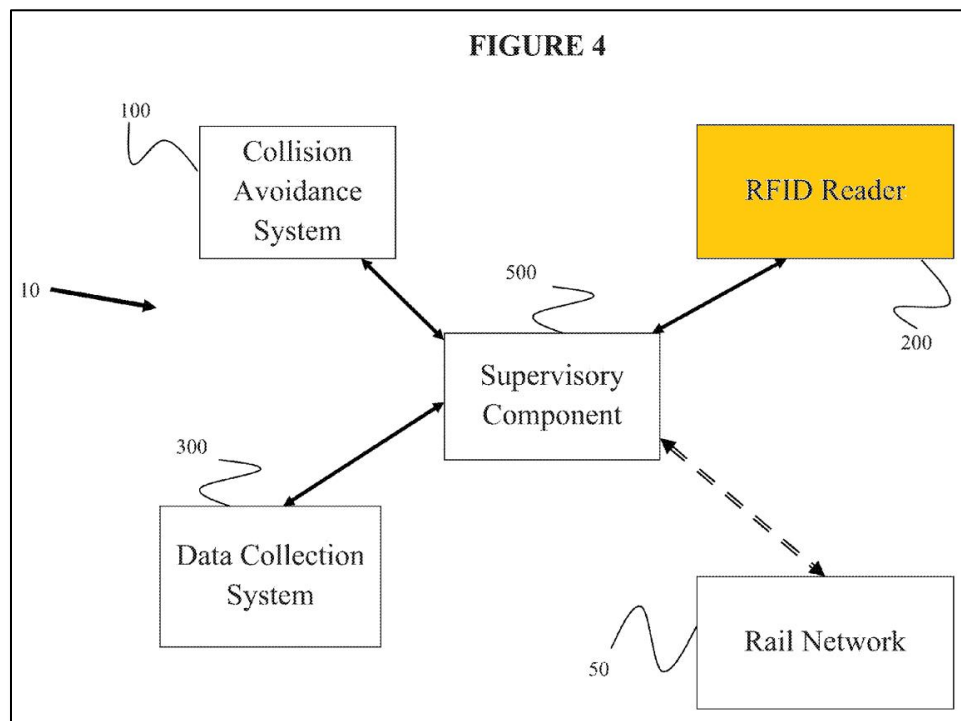
6. **Claim 5: “The system of claim 1, wherein the train-mounted unit is configured for utilizing non-UWB based signals for communicating at least some data with the wayside unit and/or another train-mounted unit.”**

VMCS 10 includes “a **second** or **redundant** wireless network,” that is “a different type than the first network,” *i.e.*, the UWB network, such as “a spread-spectrum network,” *i.e.*, a non-UWB based network. [0075]; EX1001, 6:50-54, 8:5-11 (UWB and spread-spectrum are different “wireless systems”). Other non-UWB based networks used by VMCS 10 include “Bluetooth” and/or “WiFi.” [0091]. Kain-Decl., ¶179.

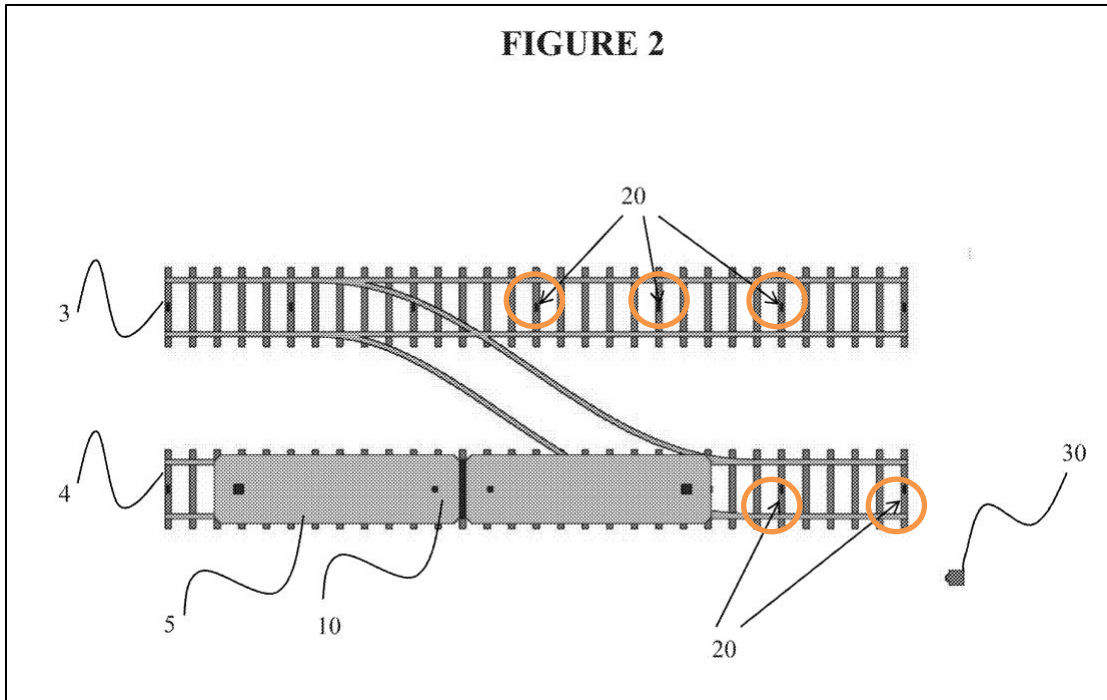
The VMCS 10’s non-UWB network is used to “transmit information [*i.e.*, data] similar to what is transmitted by the first network.” [0075]. For example, the non-UWB networks, like WiFi or Bluetooth, are used to “communicate information about the rail vehicle location, speed,” etc., to wayside reporting/signal stations as the VMCS 10 passes those stations. [0091]; *see also* [0046] (VMCS 10 indirectly communicates data to the rail network via reporting stations), [0051]-[0053] (similar); Kain-Decl., ¶180.

7. **Claim 6: “The system of claim 1, wherein the train-mounted unit is configured for handling radio-frequency identification (RFID) based signals with RFID devices used within the railway network.”**

VMCS 10 includes an RFID reader “mounted on the train,” which is configured for handling RFID-based signals transmitted by RFID devices within the system. [0042]; *see also* [0009], [0084]-[0089], FIGS. 4, 9; Kain-Decl., ¶181.



As Figure 2 (annotated below) illustrates, the RFID reader “read[s],” *i.e.*, communicates with, “RFID tags 20” mounted “at locations along the railroad track.” [0054], [0061].



Using its RFID reader, VMCS 10 retrieves information stored in the RFID signal and processes that information to perform various functions like determining the train's speed and/or location. [0011], [0014], [0042], [0044]-[0045], [0056], [0072], [0084]-[0090], claim 4; Kain-Decl., ¶¶182-183.

VMCS 10 is therefore “*configured for handling radio-frequency identification (RFID) based signals with RFID devices used within the railway network,*” as claimed. Kain-Decl., ¶184.

8. Claim 7: “The system of claim 1, wherein the train-mounted unit is configured for handling satellite based signals.”

As discussed *supra* §VII.A.3 (claim 2), VMCS 10 is configured for handling satellite-based GPS-signals. [0071]-[0072], [0090], [0094], FIG. 9; Kain-Decl., ¶185.

9. Claim 8: “The system of claim 7, wherein the train-mounted unit is configured for obtaining from received satellite based signals information, and generating or adjusting the control information based on the obtained information.”

VMCS 10 is configured for obtaining GPS-based position information from the received GPS satellite-based signals and using that data with UWB-based signals to determine distance to either another VMCS or a reporting station. [0071] (VMCS 10 uses GPS to “ensure that the time of flight technology is not providing incorrect separation distance information”), [0103] (VMCS “may use a combination of time of flight and GPS technology to more accurately detect and determine a distance between rail vehicles”); Kain-Decl., ¶¶186-187.

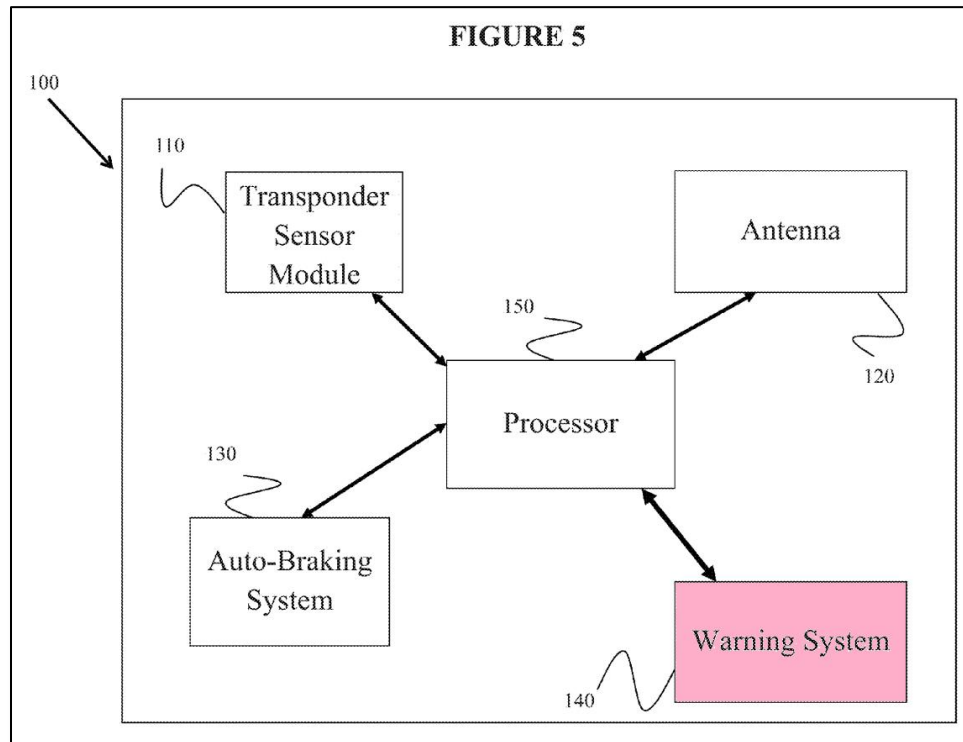
The GPS information is thus used to “*generat[e] or adjust[]*” the VMCS’s distance determination, *i.e.*, “*control information*,” as claimed. Kain-Decl., ¶187; *supra* §VII.A.2.d(2) (discussing limitation [1C2], including “control information”).

10. Claim 9: “The system of claim 1, wherein the train-mounted unit is configured for connecting to and/or interfacing with other systems of the train.”

VMCS 10 is “configured to[] **interface** with a braking system.” [0013]; *see also* Abstract. In particular, VMCS 10’s auto-braking system “work[s] with” the train’s “brakes and associated vehicle componentry,” which are “*other systems of the train*,” as claimed. [0079]; *see also* [0127], [0138]-[0139] (“interfaces with existing vehicle controls and data,” e.g., “existing brake system”), FIG. 9; Kain-Decl., ¶188.

11. Claim 10: “The system of claim 1, comprising one or more input/output (I/O) components, for receiving input from an operator of the train and/or for providing output to the operator of the train.”

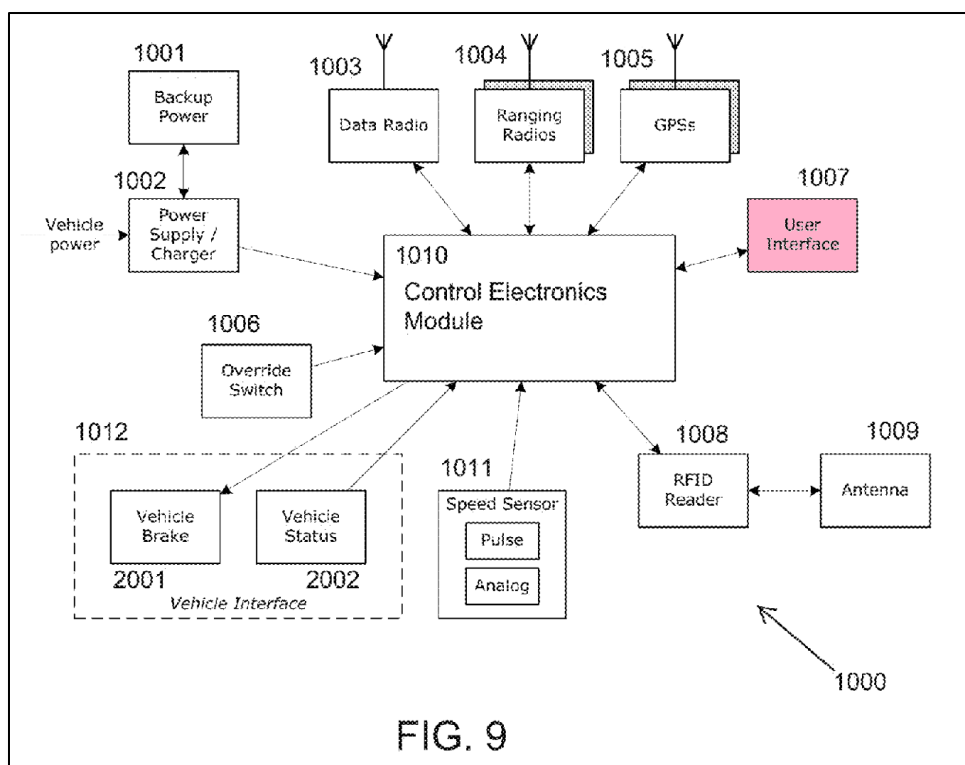
As Figure 5 (annotated below) illustrates, VMCS 10’s collision-avoidance system includes a warning system ([0065]) that provides output to the train operator by “generat[ing] an audible and/or visual warning” signal. [0080]-[0081]. The warning system is an “*output component*,” as claimed. Kain-Decl., ¶189.



The warning signal sounds “until the operator presses an acknowledge button [on] an interface.” [0081], [0082] (“confirmation button” to “quiet[.]” the warning signal). The acknowledgement/confirmation button is thus an “*input component*,”

as claimed. Kain-Decl., ¶190. VMCS 10 therefore comprises “one or more input/output (I/O) components,” as claimed.

Alternatively, as Figure 9 (annotated below) illustrates, VMCS 1000 includes a user interface. [0127]. The user interface includes I/O components like “displays, input devices, or speakers” for “receive[ing] inputs...from an operator” and “display[ing]” outputs to the operator, as claimed. [0134], [0141]-[0142]; Kain-Decl., ¶191.

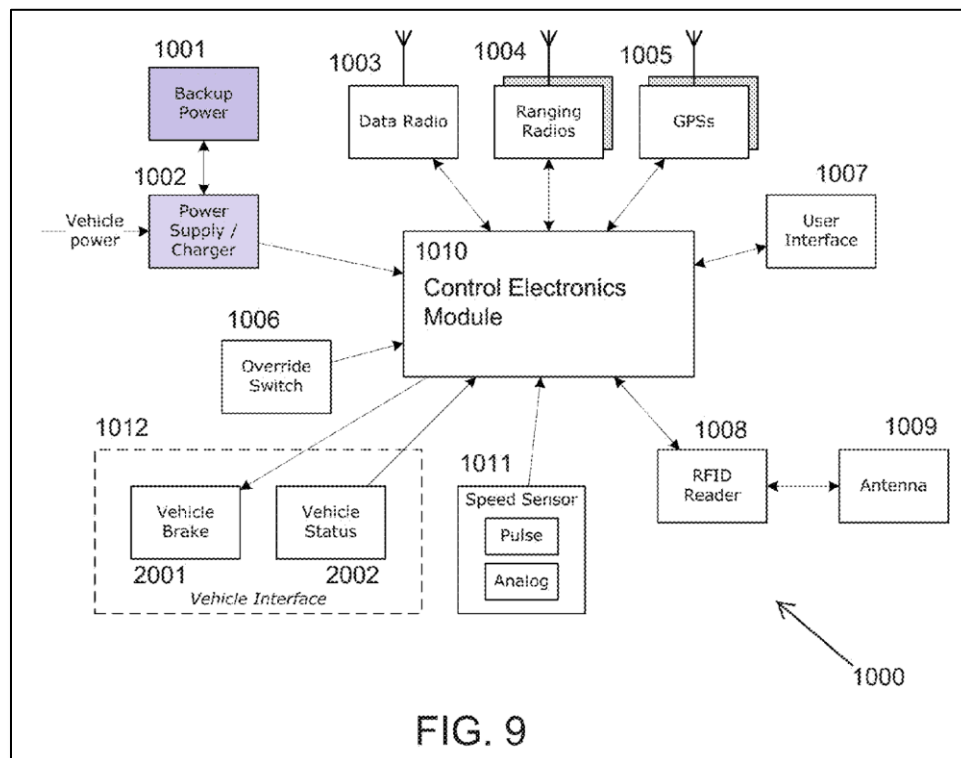


POSAs understood VMCS 10 includes the same or similar user interface to receive the inputs/outputs discussed above. Kain-Decl., ¶192. Indeed, VMCS 1000 is “similar to VMCS 10” and either can “perform the techniques disclosed therein.”

[0127]. Alternatively, POSAs had reason to include VMCS 1000's user interface when implementing VMCS 10's I/O components because both embodiments produce similar outputs to, and receive similar inputs from, vehicle operators. Compare [0080]-[0081] with [0141]-[0142]; Kain-Decl., ¶¶192-193.

12. Claim 11: “The system of claim 1, comprising a power component for supplying and/or obtaining power for components of the train-mounted unit.”

As Figure 9 (annotated below) illustrates, VMCS 1000 includes a “power supply,” which “provide[s] suitable electrical power to” the VMCS. [0128]; Kain-Decl., ¶194.



POSAs understood VMCS 10 includes the same or similar power components to supply or obtain power for its electronics components because an electronic device like VMCS 10 requires power. [0127]; Kain-Decl., ¶195. Alternatively, POSAs had reason to include VMCS 1000's power source in VMCS 10 because electronic devices like VMCS 10 require power and VMCS 1000 is "similar to VMCS 10" and both "perform the techniques disclosed" in Carlson. [0127]. Kain-Decl., ¶¶195-196.

13. **Claim 12: "The system of claim 1, wherein the train-mounted unit is configured for communicating, directly or via at least one of the wayside unit and another train-mounted unit, with one or more other components or devices in the railway network, the one or more other components or devices in the railway network not being part of decentralized train control system."**

VMCS 10 "communicates, either directly or indirectly, with a rail network 50." [0061]; *see also* [0037], [0063]; FIG. 1. Indirect communication occurs "via the reporting stations 30," *i.e.*, "*wayside units*," which relay information from the VMCS to the network. [0052]-[0053]; *supra* §VII.A.2.b (limitation 1A). Direct communication occurs "via a wireless communication mode without the use of a reporting station." [0053]. Kain-Decl., ¶¶197-198.

Using information that VMCS 10 communicates to it (directly or indirectly), the rail network "manage[s] and maintain[s]" the system "to ensure that all rail vehicles...are operating at safe distances from one another and/or are properly

distributed for timely transit operations.” [0091]. The device/component in rail network 50 that communicates with the VMCS (directly or indirectly) is “*not being part of the decentralized train control system,*” as claimed, because that device/component is part of the **centralized** aspect of the overall railway system and is not needed for VMCS 10 to make perform its autonomous operations like auto-braking. [0052] (describing rail network 50’s role in the system), [0091] (similar); [0010], [0122] (explaining VMCS “can operate autonomously and make internal operational decisions without requiring a central server”). Kain-Decl., ¶¶199-200.

14. Claim 13: “The system of claim 1, wherein the train-mounted unit is configured to substantially continually determine absolute position of the train, based on the ranging information obtained from ranging with wayside units.”

As discussed *supra* §VII.A.4.a (limitation 3A), VMCS 10 uses its UWB-based ranging information “in combination with” GPS “to determine a position (*e.g., an absolute position*)” of the vehicle. [0071]. Carlson further discloses that the ranging information VMCS 10 generates (and uses to determine its absolute position) “provides ***substantially continuous location information*** over time.” [0072]; Kain-Decl., ¶201.

The UWB-based ranging information used with GPS positional-information to substantially continually determine VMCS 10’s absolute position includes ranging information that VMCS 10 received from reporting stations, *i.e.*, “*wayside*

units.” Supra §§VII.A.2.d-VII.A.2.f (discussing limitations [1C]-[1E]). VMCS 10 is thus configured “to substantially continually determine absolute position of the train, based on the ranging information obtained from ranging with wayside units,” as claimed. Kain-Decl., ¶201.

If Carlson were not found to disclose that VMCS 10 is configured to substantially continually determine the absolute position of the train, POSAs had reason to do so. For example, substantially continually determining the absolute position of the train would have been useful information to provide rail network 50 because it “maintains information relating to the speed and **location** of the rail vehicles connected to the network.” [0052]; Kain-Decl., ¶202. POSAs understood this information would have been more beneficial than periodic updates because it provides more accurate real-time train location for safety and rail network management purposes, *e.g.*, to confirm the train is on schedule and following the correct route. Kain-Decl., ¶202.

POSAs reasonably expected success in substantially continually determining the train’s absolute position by ranging with wayside reporting/signal stations because these stations were located at “fixed positions along a railroad track,” and thus provided known (absolute positions) from which to calculate (in combination with GPS) the absolute position of the train based on distance from the station(s). [0051], [0086]; Kain-Decl., ¶¶203-204.

15. Claim 14: “The system of claim 13, wherein the train-mounted unit is configured to determine the absolute position of the train based on the ranging information and positioning information obtained without ranging to wayside units.”

As discussed *supra* §§VII.A.2.f & VII.A.14 (limitation 1E, claim 13), VMCS 10 determines “an absolute position” for the train on which it is mounted based on the “*ranging information*” it obtains from UWB-based ranging with wayside-located reporting/signal stations.

VMCS 10 also determines the train’s “*absolute position*” using “*positioning information obtained without ranging to wayside units*,” as claimed. Kain-Decl., ¶¶205-206. For example, VMCS 10 uses its UWB-derived ranging information “in combination with” GPS-derived information to calculate a train’s absolute position. [0071]; Kain-Decl., ¶206. GPS-derived information is from satellites and is “*positioning information obtained without ranging to wayside units*,” as claimed. Kain-Decl., ¶206.

Additionally, VMCS 10 “senses RFID tags 20...located along a railroad track.” [0061]. Each RFID tag has a known location stored in a database, which “VMCS 10 can consult...to determine the location of the RFID tag 20, and thus, the location of the rail vehicle.” [0086]; *see also* [0100] (RFIDs have known “latitude and longitude coordinates” that can be used to determine “precise” vehicle location), [0045]. Location information based on RFID-derived coordinates is “*positioning*

information obtained without ranging to wayside units,” as claimed. Kain-Decl., ¶207; see EX1001, 10:3-11 (explaining “absolute position” determined by referencing known location of wayside devices).

Finally, as discussed *infra* §VII.A.16 (claim 15), VMCS 10 also communicates with each reporting/signal station it passes, which provide their identification to VMCS 10 so it can determine (via a map) its location relative to the reporting/signal station’s known location. [0086]; Kain-Decl., ¶¶208-209.

16. Claim 15: “The system of claim 14, wherein the train-mounted unit is configured to obtain at least portion of the positioning information from each wayside unit as the train passes the wayside unit.”

Claim 15 requires at least part of “*the positioning information*” of claim 14, *i.e.*, the information obtained “*without ranging to wayside units,*” be obtained from “*each wayside unit as the train passes the wayside unit.*” The claim aligns with an embodiment wherein each wayside anchor has an “ID number” that it transmits to a passing train so the train can “referenc[e] the distance to that anchor with [an] on-board track map.” EX1001, 10:3-11; Kain-Decl., ¶210.

In addition to obtaining ranging information from reporting/signal stations, Carlson discloses that VMCS 10 also obtains non-ranging information/data from reporting/signal stations, *i.e.*, “*wayside units,*” as claimed. [0046] (trains and reporting stations “communicate wirelessly...to transmit and receive relevant vehicle information *as the rail vehicle passes the reporting station*”), [0051]

(reporting station “include[s] a communication mechanism that allows the rail vehicles and/or the VMCS 10 installed on the rail vehicles to ***exchange data and information...***”), [0057]-[0058] (similar), [0060] (reporting stations “communicate...with a VMCS 10 mounted on a ***passing*** rail vehicle”). Kain-Decl., ¶211.

Carlson further explains that VMCS 10 can determine its location based on its distance from a reporting/signal station having a known location. [0086] (“If the signal control point 30 is known and the distance of the VMCS 10 from the signal control point is known, then location can be determined.”). POSAs thus understood at least part of the information that reporting stations transmit to a passing VMCS 10 is identification of the reporting stations so the VMCS could determine its location relative to the reporting station’s known location. Kain-Decl., ¶212.

If Carlson is found not to disclose that VMCS 10 obtains positioning information from reporting stations, POSAs would have had reason to implement Carlson’s reporting stations to transmit positional information to VMCS 10. For example, Carlson teaches that wayside-located RFID-devices advantageously transmit “location information” to VMCS 10 so the VMCS can determine its position more accurately, *e.g.*, when GPS is unavailable/unpredictable. [0008], [0037], [0045], [0049]; Kain-Decl., ¶213. Having reporting stations provide similar information to VMCS 10 would have improved Carlson’s system by providing a

redundant source of positioning information, *e.g.*, in case RFID-devices malfunctioned. Thus, POSAs had reason to implement Carlson's reporting stations such that they transmitted their location to VMCS 10 when the train on which the VMCS was mounted passes the reporting station, as claimed. Kain-Decl., ¶¶213-214.

17. Claim 16: “The system of claim 15, wherein the train-mounted unit is configured to obtain at least portion of the positioning information from at least one wayside unit as the train passes that wayside unit using non-UWB communications.”

As discussed *supra* §VII.A.16 (claim 15), VMCS 10 receives non-ranging-based position information from reporting stations, *i.e.*, “*wayside units*,” as claimed, when the train on which the VMCS 10 is mounted passes the station. These transmissions occur over “communication link 35.” [0060]. As also discussed *supra* §VII.A.16 (claim 15), POSAs separately had reason to implement Carlson's VMCS 10 to receive non-ranging-based position information from reporting stations. For the reasons discussed below, POSAs had reason to implement VMCS 10 to use non-UWB communications for transmission of non-ranging-based position information. Kain-Decl., ¶215.

VMCS 10 includes a “second or redundant wireless network” that is a “different type than the first [UWB-based] network” to “transmit information.” [0075]; *supra* §VII.A.6 (claim 5). Carlson further teaches that VMCS 10 and

reporting stations “exchange data and information” using non-UWB wireless technologies like Bluetooth or cellular. [0051]. Kain-Decl., ¶216.

Carlson thus suggested, and POSAs had reason (*e.g.*, redundancy) to have the reporting stations transmit non-ranging positional information to VMCS 10 using VMCS 10’s “second or redundant wireless network” that is different from its first, UWB-based network. POSAs would have selected from any suitable wireless technology Carlson identifies ([0051]) such as Bluetooth or cellular because those technologies were well-known and proven information-communication technologies. Kain-Decl., ¶216.

Implemented as set forth above, VMCS 10 would be “*configured to obtain at least portion of the positioning information from at least one wayside unit as the train passes that wayside unit using non-UWB communications,*” as claimed. Kain-Decl., ¶217.

B. Ground 2: Claims 1-14 Obvious Over Ghaly and Heddebaut

1. Ghaly (EX1008)

Ghaly describes a “train control system” that uses “communication based train control (CBTC) technology.” Ghaly, [0001]. “CBTC technology is [] known in the art” and “is based on continuous two-way communications between intelligent trains and Zone controllers.” *Id.*, [0003]. “An intelligent train,” Ghaly explains, “determines its own location, and generates and enforces a safe speed profile.” *Id.*

In CBTC systems, intelligent trains receive “speed commands” and autonomously adjust their speed to comply with those commands. Ghaly, [0001], [0003]-[0004]; Kain-Decl., ¶¶219-223.

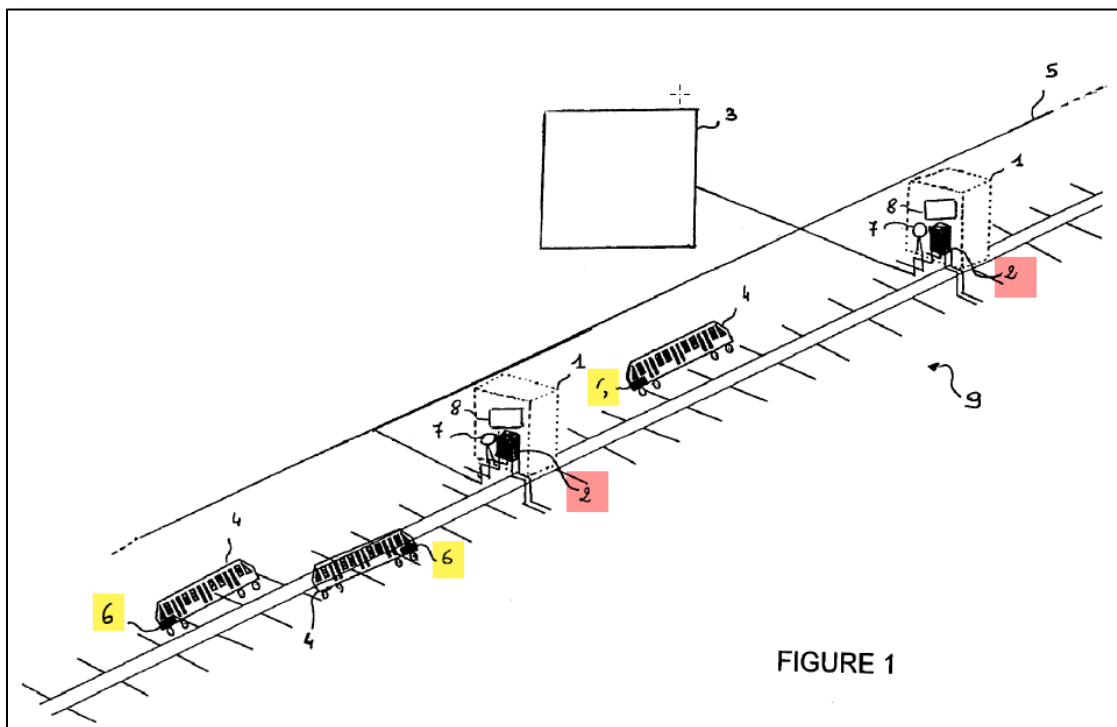
Ghaly’s intelligent train includes “an independent location and speed determination subsystem.” Ghaly, [0010]. Ghaly explains that “there are a number” of prior-art techniques to determine trains’ location and speed, including “transponders that are located on the track...to provide reference locations to approaching trains.” *Id.*, [0003]. The transponders can be either “passive” or “dynamic,” and Ghaly is explicit that “**any** location and speed determination system that is independent of the wayside track circuits could be used.” *Id.*; Kain-Decl., ¶¶223-225.

The train’s “vital onboard controller (VOBC)” interfaces with a “transponder reader” and other train sub-systems. Ghaly, [0026]. The transponder reader “receives location information” from the on-track transponders, which it “provides...to the on-board location determination subsystem.” *Id.* The location determination system generates a “CBTC train location.” Ghaly, [0028]. Based on the determined location, the VOBC generates a movement-authority limit for the train (Ghaly, [0028]) and/or a “stopping profile (speed/distance curve) to control the speed of the train” (Ghaly, [0038]). Kain-Decl., ¶¶226-231.

2. Heddebaut (EX1009)

Heddebaut discloses a system for “positioning and controlling” trains that uses “ultra wide frequency bands,” which are “simple in their design,” have “very high transfer rates,” are “economical,” “limit[] the risks of interference[],” and provide “highly available” coverage. Heddebaut, Abstract, 1:64-2:8; Kain-Decl., ¶¶237-239.

Heddebaut discloses a first set of “transmitting/receiving” elements associated with “fixed stations” and second “transmitting/receiving” elements associated with “each railway vehicle.” Heddebaut, Abstract; 3:58-61; 4:14-15; Kain-Decl., ¶¶234-236. Heddebaut’s Figure 1 (below) depicts the transmitting/receiving elements of the fixed stations (red) and train (yellow):



Each transmitting/receiving element sends a “signal” that “contain[s] a specific identifier of the transmitter and at least one message.” Heddebaut, 4:15-18. Each identifier is a “specific identity...ascribed to [the] transmitter” and is transmitted using “an ultra wide band technique.” Heddebaut, 4:27-38.

The UWB-signals transmitted/received by the transmitting/receiving elements are especially suited for “propagating efficiently in an underground tunnel” and provide “optimal radioelectric coverage” for “an automated underground train.” Heddebaut, 4:52-62, 5:2-5.

The “speeds and positions of [the] rail vehicles” can be determined “on-board the rail vehicle” based on “analysis of the ultra wide band signals exchanged between the ground and the vehicles.” Heddebaut, 5:51-56. Accordingly, “[a]ll the rail vehicles” can “calculate their distances to the downstream and upstream fixed stations.” Heddebaut, 5:57-61. To do so, the rail vehicle uses “the flight time of signals,” which “corresponds to a distance travelled through the air.” Heddebaut, 6:3-18. These UWB-ranging measurements can also be used to determine an “actual speed measurement of the rail vehicle.” Heddebaut, 6:18-24; Kain-Decl., ¶¶240-243.

3. The Ghaly-Heddebaut Combination

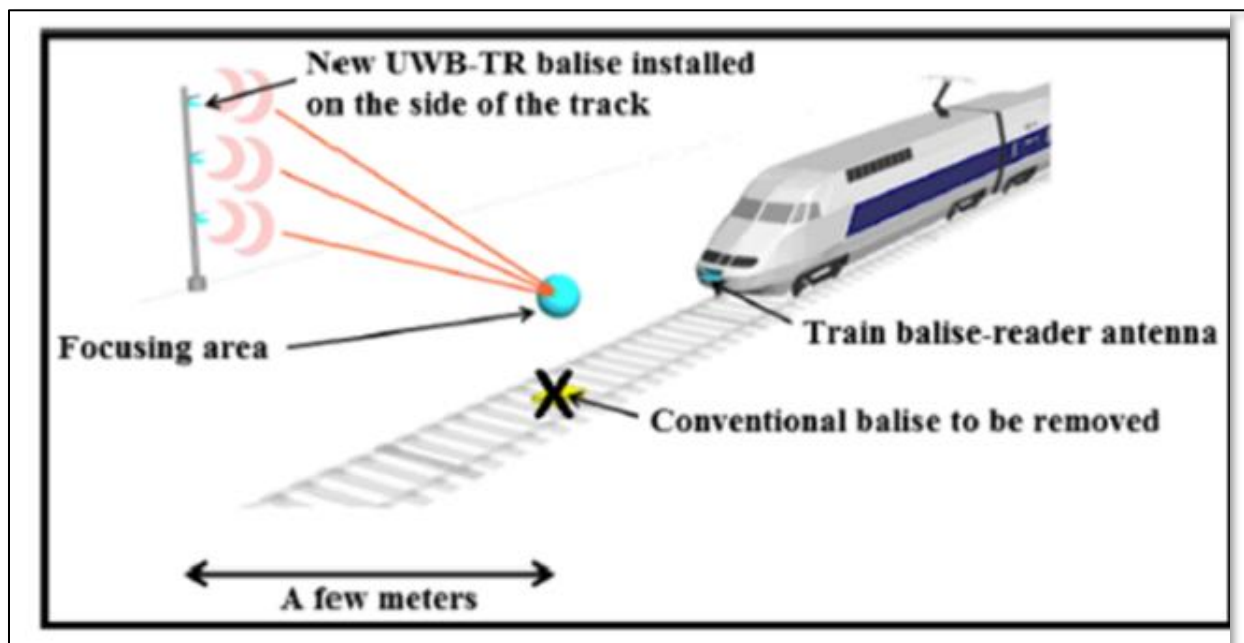
POSAs would have had reason to implement Ghaly’s CBTC system using Heddebaut’s UWB-based transmitting/receiving elements as the location/speed-

determination technologies for Ghaly's location- and speed-determination subsystem. Kain-Decl., ¶¶244-256. As Ghaly notes, its CBTC system can use "any location and speed determination system that is independent of the wayside track circuits," which POSAs would have understood to include Heddebaut's UWB-based system. Kain-Decl., ¶245. POSAs had several reasons to pursue the Ghaly-Heddebaut combination.

First, Ghaly describes a location-determination subsystem that uses a "transponder reader" to receive "reference location information" from track-based transponders. Ghaly, [0003], [0026]. Heddebaut's UWB-transmitters/receivers are located along a track and similarly provide a reference location to an on-train unit, enabling the on-train unit to determine a distance between the train and the transponder. Kain-Decl., ¶246. The combination thus would have been the simple substitution of one known element (Ghaly's transponders) with another known element (Heddebaut's UWB-transmitters/receivers) to obtain a predictable result (wireless determination of train location). Kain-Decl., ¶246; *KSR Int'l v. Teleflex*, 550 U.S. 398, 417 (2008).

Second, Heddebaut explicitly motivates POSAs to use its UWB-based transmitters/receivers in Ghaly's train-control system by teaching several benefits to UWB technology, including benefits specific to underground train systems. Heddebaut, 1:64-2:8, 4:52-5:5; Kain-Decl., ¶247.

Third, other prior-art references specifically contemplated the proposed combination and thus would have provided POSAs motivation to implement it. Kain-Decl., ¶¶248-256. For example, a 2014 publication taught that a UWB-transmitter could be “installed on the side of the track,” allowing for removal of an on-track transponder:



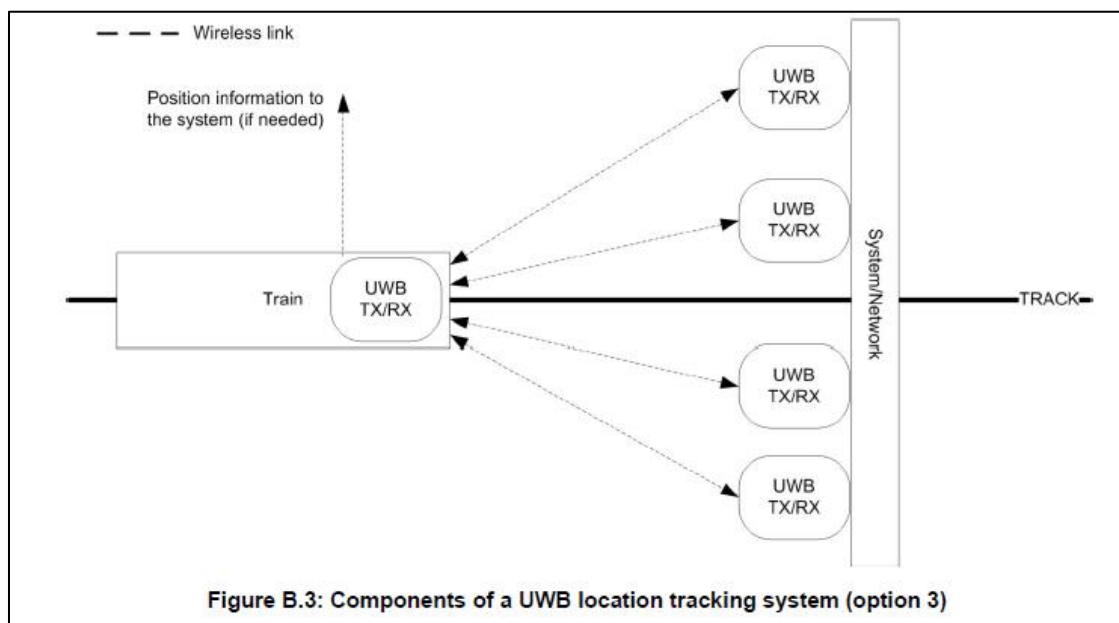
EX1012; Kain-Decl., ¶248.

Similarly, a 2004 article described “utilizing ultra wideband radio technology” and providing “nodes along a railway right-of-way” to provide “precise information on the location and velocity of trains.” EX1026, Abstract.

By October 2012, the European Telecommunications Standards Institute, a leading standards-setting organization, had produced a Technical Report (EX1018, “ETSI-Report”) describing the use of UWB radios for “location tracking

applications in a railway environment.” ETSI-Report, 4. The ETSI Report emphasized that “[u]sing UWB in railway could increase the train positioning accuracy.” ETSI-Report, 20. It further advertised that UWB provides “high-level performances and benefits,” namely, “high accuracy positioning.” ETSI-Report, 10; *see also id.*, 9-10, 21, 23 (noting UWB provides “sub-meter accuracy,” even in difficult propagation environments (*e.g.*, tunnels)).

The ETSI Report provided several example “options for implementation,” each featuring a “UWB transmitter (TX) [] installed in a moving train” and “a network of fixed receivers (RX)” “placed at known, fixed points” along the track.



For example, the figure below depicts “[i]nstallation of devices in [a] subway,” where a “UWB transmitter...is installed in a train and UWB receivers...are mounted in the ceiling:

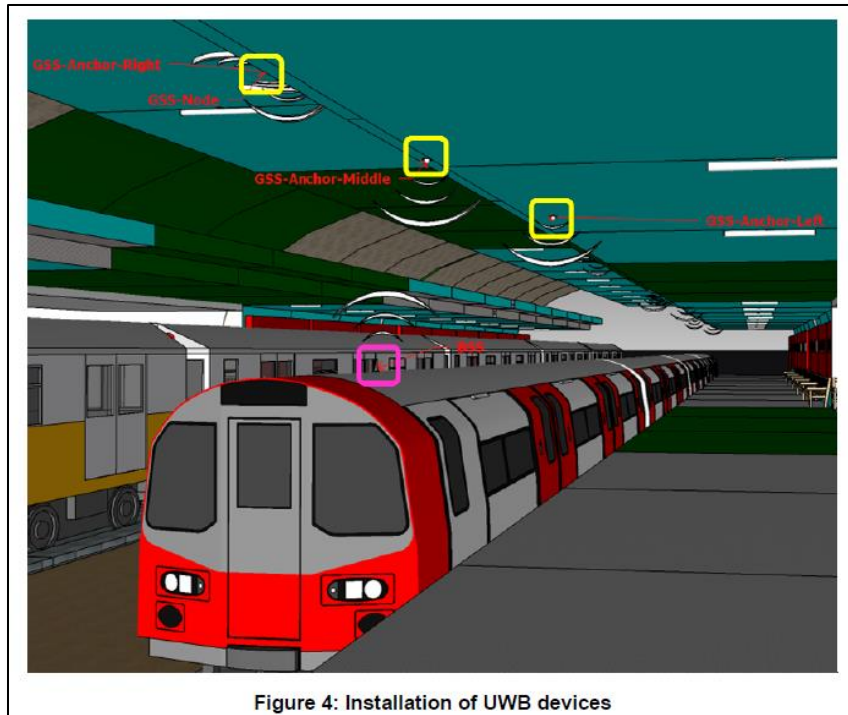


Figure 4: Installation of UWB devices

These references demonstrate a widespread recognition of UWB ranging for train-positioning and train-control before August 2017. Kain-Decl., ¶¶248-256. Pursuing the Ghaly-Heddebaut combination would thus have been the use of a known technique (UWB-based location and speed determination) to improve similar devices (train-control systems) in the same way as had been taught in the art. Kain-Decl., ¶¶248-256; *KSR*, 550 U.S. at 417.

In Ghaly-Heddebaut, Ghaly’s location and speed determination system would have used Heddebaut’s UWB-based transmitters/receivers to calculate train location and speed and to generate a “CBTC train location.” Ghaly, [0028]. All other aspects of Ghaly’s system would remain unchanged. Kain-Decl., ¶244.

4. Claim 1

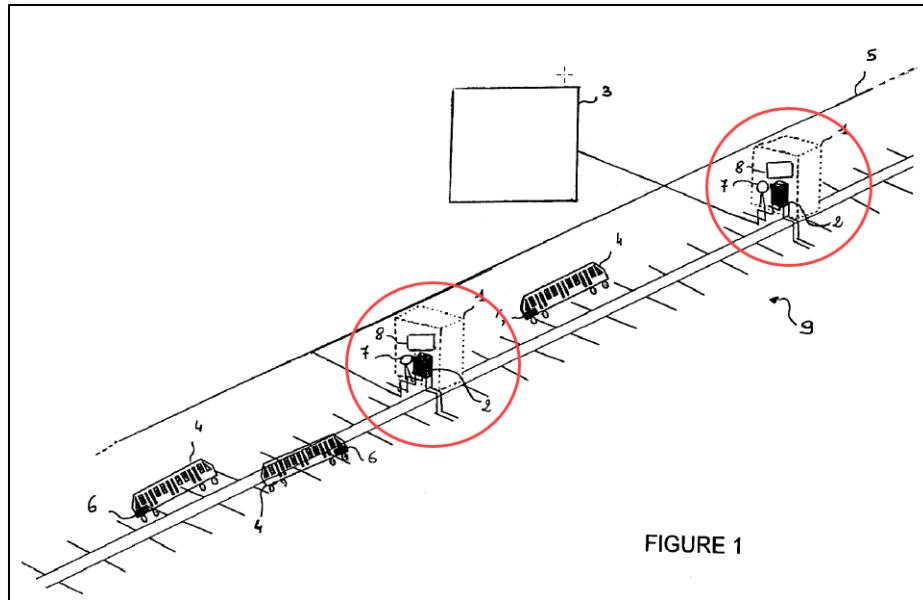
a. [1PRE]: “A system for providing decentralized control operations in a railway network”

Although not limiting (*supra* §VII.A.2.a), Ghaly-Heddebaut meets the preamble.

Ghaly-Heddebaut includes Ghaly’s “intelligent train” that “determines its own location, and generates and enforces a safe speed profile.” Ghaly, [0003]. The train’s “onboard CBTC device” includes “an independent location and speed determination subsystem.” Ghaly, [0009]-[0010]. The onboard CBTC device “receives wayside speed limit information coded in electrical signals” and, based on train location/speed, autonomously controls the train by generating and implementing a “speed profile.” Ghaly, [0013]; Kain-Decl., ¶¶257-263.

b. [1A] “a plurality of wayside units...on or near tracks...”

Ghaly-Heddebaut includes Heddebaut’s UWB-based receivers/transmitters as the transponders that Ghaly teaches are “located on the track.” Ghaly, [0003]; Kain-Decl., ¶¶264-265. This is consistent with Heddebaut, which positions its receivers/transmitters along the track:



c. [1B] “one or more train-mounted units...”

Ghaly-Heddebaut’s “onboard train control device” includes “a vital onboard controller (VOBC).” Ghaly, [0024]-[0026]; Kain-Decl., ¶¶266-268.

d. [1C] “wherein each train-mounted unit...”

- (1) [1C1] “communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals”**

The VOBC “interfaces with a transponder reader,” which is a train-mounted UWB-transmitter/receiver in Ghaly-Heddebaut. Ghaly, [0026]; Heddebaut, 4:14-18. The VOBC’s train-mounted transmitter/receiver “exchange[s]” signals (specifically, UWB-signals) with UWB-transmitters/receivers positioned along the track. Heddebaut, 5:49-56; Kain-Decl., ¶¶269-271.

Ghaly-Heddebaut's on-train and on-track UWB-transmitter/receivers communicate "radio signals with a very large passband" with a "frequency spectrum [that] ranges between 1 and 10 GHz," *i.e.*, UWB-based signals. Heddebaut, 4:52-55; Kain-Decl., ¶¶272-274. As Heddebaut explains, the "[characteristics] of an ultra wide band signal enable to dispense with difficult propagation conditions in [a] tunnel." Heddebaut, 4:52-65; *see also* 5:2-17.

(2) [1C2] "generate based on the communication, control information..."

Ghaly-Heddebaut's VOBC generates a "CBTC train location" (Ghaly, [0028]) by using Heddebaut's UWB-transmitter/receiver to "calculate [its] distance[] to" each UWB-transmitter/receiver on the track. Heddebaut, 5:57-61; Kain-Decl., ¶¶275-277. This distance calculation is based on "analysis of the ultra wide band signals exchanged between the [track-located UWB-transmitters/receivers] and the [train-located UWB-transmitter/receiver]." Heddebaut, 5:49-56. The VOBC can also use the UWB-transmitters/receivers, and the UWB signals they exchange, to determine an "actual speed measurement." Heddebaut, 6:18-21; Kain-Decl., ¶278. Thus, Ghaly-Heddebaut's determination of the train's location (and speed) is "*based on the communication [of UWB-based signals between the train and the wayside units],*" as claimed. Kain-Decl., ¶¶275-279.

Moreover, VOBC generates a movement-authority limit (Ghaly, [0028]) and/or a “stopping profile (speed/distance curve) to control the speed of the train” (Ghaly, [0038]). These operations are “*based on*” VOBC’s location/speed determination insofar as the “CBTC train location” is “required” to generate the operations. Ghaly, [0028]; Kain-Decl., ¶¶275-277. Likewise, the enforcement of the stopping profile is “*based on*” VOBC’s location/speed determination insofar as the stopping profile can be used to provide “over-speed protection.” Ghaly, [0038]; Kain-Decl., ¶¶275-279.

e. [1D] “wherein generating the control information comprises or is based on obtaining ranging measurements”

Ghaly-Heddebaut’s VOBC generates control information using Heddebaut’s UWB-transmitter/receiver, which enables the VOBC to “calculate [its] distance[]” to companion UWB-transmitters/receivers located along the track based on “analysis of the [UWB] signals exchanged between.” Heddebaut, 5:49-61. POSAs would have understood these calculations to be “*ranging measurements*” within the context of the ’363 patent. Kain-Decl., ¶¶280-283.

f. [1E] “wherein obtaining the ranging measurements comprises”

(1) [1E1] “broadcasting ultra-wideband (UWB) based signals...”

As discussed in connection with limitation [1D], Ghaly-Heddebaut uses Heddebaut’s UWB-transmitters/receivers to perform “*ranging measurements*.”

POSAs would have understood Heddebaut to teach that these ranging measurements are performed by, *inter alia*, broadcasting UWB-based signals as claimed. Kain-Decl., ¶¶284-289.

In particular, VOBC’s train-based UWB-transmitter/receiver transmits UWB signals using a broadcast, *i.e.*, one-to-many, technique because the signals are communicated to several UWB-transmitters/receivers on the track simultaneously. Heddebaut, 5:57-61 (rail vehicles “calculate their distances to the downstream and upstream fixed stations [plural]”); Kain-Decl., ¶¶284-285.

If Ghaly-Heddebaut is found not to disclose that VOBC’s train-based transmitter/receiver broadcasts UWB signals, then POSAs had reason to implement VOBC such that it broadcasted UWB signals for at least the same reasons as discussed above with respect to Carlson. *Supra* §VII.A.2.f(1) (Ground 1, limitation 1E1); Kain-Decl., ¶¶286-288.

(2) [1E2] “the UWB based signals comprising information identifying the train-mounted unit”

Ghaly-Heddebaut’s UWB radios (*i.e.*, the on-train and trackside UWB-transmitters/receivers) send a “signal” that “contain[s] a specific identifier of the transmitter and at least one message.” Heddebaut, 4:15-18. Each identifier is a “specific code and a specific identity...ascribed to [the] transmitter” and can be transmitted using “an [UWB] technique.” Heddebaut, 4:27-38; Kain-Decl., ¶¶290-292.

(3) [1E3] “selecting based on received responses to the broadcast UWB based signals, one or more of the plurality of wayside units”

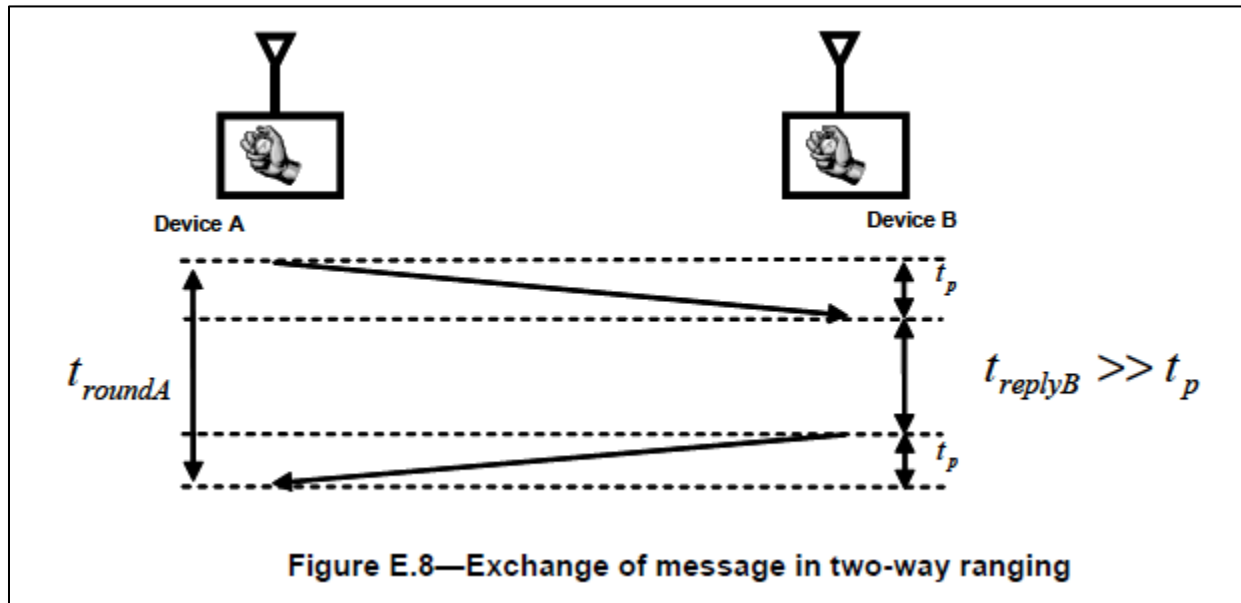
As explained *supra* §VII.A.2.f(3) (Ground 1, limitation 1E3), the “selecting” recited in [1E3] requires receiving responses from any wayside unit that responds to the train-mounted unit’s originally-broadcasted UWB signals. Kain-Decl., ¶293.

Ghaly-Heddebaut’s VOBC “calculate[s] [its] distance[] to the downstream and upstream” UWB-transmitters/receivers located along the track based on “the analysis of the [UWB] signals exchanged [there]between.” Heddebaut, 5:49-61. More specifically, it “[m]easur[es] the distance...based on the flight time” of these exchanged signals. Heddebaut, 6:2-18; Kain-Decl., ¶¶294-295.

POSAs would have understood Heddebaut’s “calculations” and “measurements” to be a form of two-way distance ranging. Kain-Decl., ¶¶294-300. In conventional two-way ranging, a first device (here, the VOBC) broadcasts a ranging request message that is received by a second device (here, a UWB-transmitter/receiver along the track). Kain-Decl., ¶¶296-298. The second device sends a message in response to the message received from the first device. *Id.* The first device can then use the round-trip time of flight to calculate the distance. *Id.*

Two-way ranging was well-known in the art, and POSAs would have understood Heddebaut’s reference to determining distance “based on the flight time” of signals “***exchanged between***” UWB radios to disclose the use of these well-

known techniques. *Id.* Indeed, using two-way ranging to perform distance determinations using UWB signals had been standardized by 2011. *Id.* Specifically, IEEE 802.15.4a discloses conventional two-way ranging, as depicted between Device A and Device B below:



EX1019, 272; Kain-Decl., ¶¶296-298.

POSAs would have understood Heddebaut’s description of UWB-based time-of-flight distance calculations to disclose the use of conventional two-way ranging, which requires the transmitting UWB-transmitter/receiver to select one or more “responses to the broadcast UWB based signals,” as claimed. Kain-Decl., ¶¶293-300.

(4) [1E4] “determining ranging information ...based on ultra-wideband (UWB) based signals communicated respectively with...wayside units.”

As discussed in connection with limitation [1E3], VOBC, using its UWB-transmitter/receiver, “calculate[s] [its] distance[]” to trackside UWB-transmitters/receivers based on “the analysis of the [UWB] signals exchanged between” the devices. Heddebaut, 5:49-61. POSAs would have understood the distance to each responsive UWB-transmitter/receiver with which UWB signals are exchanged to be “*ranging information*,” as claimed. Kain-Decl., ¶¶301-303.

5. Claim 2

Claim 2 requires that the “*train-mounted unit*” be “*configured to generate at least part of the control information based on sources*” other than the UWB-signals it exchanges with wayside units.

Ghaly-Heddebaut’s movement-authority limits and stopping profiles (“*control information*”) are based on sources other than the train’s location and speed, *i.e.*, other than the information VOBC obtains from UWB-based signals it exchanges with wayside units. For example, the stopping/speed profile “incorporates the civil speed limits” and “takes into account...the topography of the track, and the braking characteristics of the train.” Ghaly, [0004]; *see also* [0009]-[0011]; Kain-Decl., ¶¶305-307.

6. Claim 3

Claim 3 requires claims 2's "*train-mounted unit*" be configured to "*assess based on the processing of the [UWB-signals] one or more conditions relating to operation of the train*" and if such conditions meet a "*particular criteria*" to "*perform or cause performing*" of a "*responsive action*["."

Ghaly-Heddebaut's VOBC uses Heddebaut's "ultra wide band technology" to determine the train's "distance relative to" trackside UWB-transmitters/receivers and "deriv[es] from this distance" an "actual speed measurement" for the train. Heddebaut, 6:4-21. The train's speed is a condition relating to operation of the train that is assessed based on the processing of UWB signals, as claimed. Kain-Decl., ¶308.

In operation, Ghaly-Heddebaut's VOBC "generate[s] a stopping profile (speed/distance curve) to control the speed of the train" and "provides over-speed detection by ensuring that the actual speed of the train...does not exceed the allowable speed limit determined by the generated stopping profile." Ghaly, [0038]. If VOBC determines that the train speed "exceed[s] the allowable speed limit determined by the generated stopping profile" (*i.e.*, that the condition meets one or more criteria), "VOBC will activate the train brake subsystem." Ghaly, [0038]; Kain-Decl., ¶309.

7. Claim 4:

Claim 4 requires that claim 3’s “*responsive action[]*” comprises “*providing indication or feedback...to a train operator*” and that the “*train-mounted unit*” “*monitor*” the operator, “*assess...compliance with...[an] expected...responsive action*” and, if the operator does not perform the action, “*perform*” the action.

Ghaly-Heddebaut’s VOBC includes and/or interfaces with a “train operator display” that provides information to the train operator. Ghaly, [0048]. POSAs would have understood that this display was used to provide feedback to the operator relating to a train “*condition*,” such as by providing feedback relating to the train’s location/speed and/or its compliance with a movement-authority limit or stopping profile. Kain-Decl., ¶310. If not explicitly disclosed in Ghaly, then POSAs had reason to display such information to the operator in Ghaly-Heddebaut, *e.g.*, provide the operator with necessary information to control the train and monitor compliance with speed limits, stopping requirements, etc. Kain-Decl., ¶311.

Additionally, the VOBC “enforces a safe speed profile” by providing “over-speed detection.” Ghaly, [0003], [0038]. The VOBC monitors and assesses whether the “speed of the train” has “exceed[ed] the allowable speed limit.” Ghaly, [0038]. If the train has exceeded the speed limit without the operator taking action to bring the train back into compliance, the VOBC will directly perform a responsive action by “activat[ing] the train brake subsystem.” Ghaly, [0038]; Kain-Decl., ¶¶312-317.

8. Claim 5

Claim 5 requires that the “*train-mounted unit*” uses non-UWB-signals to communicate with one of the “*wayside unit[s] and/or another train-mounted unit.*”

Ghaly-Heddebaut’s VOBC can communicate other system components using a “data communication network.” Ghaly, [0022]. Ghaly states that the communication is “normally in the form of a modulated carrier frequency,” which POSAs would have understood to include non-UWB signals. Ghaly, [0027]; Kain-Decl., ¶¶318-319. POSAs would have had reason to implement Ghaly-Heddebaut’s VOBC to be capable of using this non-UWB communication network for communications to provide redundancy and/or to provide the capability to communicate with any components (e.g., other trains) not equipped with UWB-communication capabilities. Kain-Decl., ¶319.

9. Claims 6 and 7

Claims 6 and 7 require that the “*train-mounted unit*” be configured for “*handling,*” RFID-based signals or satellite-based signals, respectively.

As discussed *supra* §VII.B.3, Ghaly-Heddebaut uses UWB-transmitters/receivers to determine a train’s position and speed within the system. POSAs, however, would have understood that Ghaly-Heddebaut need not be limited to one position/speed-determination technique and that there were advantages to using additional techniques. Kain-Decl., ¶¶320-328.

For example, using multiple position/speed-determination subsystems would allow Ghaly's VOBC to, *e.g.*, combine or compare the location/speed outputs of different subsystems to improve system accuracy and account for scenarios in which any of the position-speed subsystems is inoperable or unavailable. Kain-Decl., ¶321. This type of "sensor fusion" was commonplace in train-control (Kain-Decl., ¶323), and would be particularly advantageous when trains travel through different environments where different location-determination techniques vary in accuracy (Kain-Decl., ¶¶322-325). Given these advantages, POSAs would have had reason to implement Ghaly-Heddebaut such that it used one or more position-speed subsystems commonly used in decentralized train-control systems. *Id.*

One such subsystem uses RFID transponders at fixed (and known) locations along a track that communicate with an RFID reader on-board the train to provide the train with information needed to determine its absolute position and speed within the system. Kain-Decl., ¶¶326-328 (citing, *e.g.*, EX1024, 9:44-10:8). POSAs would have reason to use, and reasonable expectation of success in using, a conventional RFID position-location subsystem in Ghaly-Heddebaut. Kain-Decl., ¶¶327-328.

Another common position-location subsystem is the use of global positioning devices (GPS) that acquire absolute positioning information from satellite signals. Kain-Decl., ¶¶329-333. Indeed, Ghaly explicitly motivates using GPS signals in its system as it identifies "global positioning devices" as one form of location-speed

determination subsystem. Ghaly, [0011]. POSAs would have reason to use, and reasonable expectation of success in using, a conventional GPS position-location subsystem in Ghaly-Heddebaut. Kain-Decl., ¶¶329-333.

10. Claim 8

Claim 8 requires that claim 7’s “*train-mounted unit*” use information obtained from satellite-based signals to “*generat[e] or adjust[] the control information.*”

As discussed *supra* §VII.V.9 (claim 7), Ghaly discloses using “global positioning devices (GPS)” for its location-determination subsystem, thus motivating POSAs to incorporate GPS positioning into the location-determination subsystem. The acquired GPS information would be one of multiple inputs to determine the “CBTC train location,” which is used to generate and enforce a stopping profile. See Ghaly, [0028]; Kain-Decl., ¶¶334-335.

11. Claim 9

Claim 8 requires that claim 1’s “*train-mounted unit*” “*connect[s] to and/or interface[es] with other systems of the train.*”

Ghaly-Heddebaut’s VOBC includes “an interface to the traction, braking and other car subsystems.” Ghaly, [0010], [0026]; Kain-Decl., ¶¶336-337.

12. Claim 10

Claim 10 requires that claim 1’s system also include “*input/output (I/O) components*” for receiving inputs from and providing outputs to the train’s operator.

Ghaly-Heddebaut's VOBC includes and/or is operatively connected to a "train operator display" that provides information to the train operator, such as "route information." Ghaly, [0048]. POSAs would have understood that such a display would be capable of receiving input from the train operator. Kain-Decl., ¶¶338-340. For example, Ghaly provides that the VOBC can implement an "acknowledgement function...to ensure that the train operator is aware of" an updated movement authority limit. Ghaly, [0017], [0044]. POSAs would have understood that the VOBC's display includes an input for accomplishing the "acknowledgement function" and/or would have implemented Ghaly-Heddebaut to include such an input to accomplish the function. Kain-Decl., ¶¶338-340.

13. Claim 11

Claim 11 requires that claim 1's system include a "*power component*" for supplying power to the train-mounted unit's components.

Ghaly-Heddebaut's VOBC is an "on-board computer," and POSAs would have understood it to be conventional and routine to connect VOBC to a "*power component*" to power its electronics. Kain-Decl., ¶¶341-342.

14. Claim 12

Claim 12 requires that the "*train-mounted unit*" communicate directly or indirectly with component(s) in the railway network that is not "*part of decentralized control system.*"

VOBC “communicate[s] with an Automatic Train Supervision System (ATS),” which is “enabled by [an] ATS dispatcher at a central control location” ([0017]) and which “provides information related to temporary speed restrictions, work zone limits, and status of interlocking devices.” Ghaly, [0009], [0032]; Kain-Decl., ¶¶343-344.

15. Claim 13

Claim 13 requires that the “*train-mounted unit*” “*substantially continually determine absolute position of the train, based on the ranging information obtained from ranging with wayside units.*”

Ghaly-Heddebaut’s VOBC “continuously calculates the location and speed of the train.” Ghaly, [0010]. The VOBC utilizes Heddebaut’s UWB-based location-determination techniques to determine “distance relative to [] fixed reference[s] upstream and/or downstream,” which VOBC can use to determine “the absolute position of the guided mobile,” *i.e.*, the train. Heddebaut, 6:3-9; Kain-Decl., ¶345.

16. Claim 14

Claim 14 requires that claim 13’s “*train-mounted unit*” also use “*positioning information obtained without ranging to wayside units*” to determine its absolute position.

Ghaly-Heddebaut’s VOBC includes a “vital data base that includes...location of wayside signal devices.” Ghaly, [0010]. POSAs would have had reason to use this

database to store the location of Heddebaut's trackside UWB-transmitters/transmitters. Kain-Decl., ¶¶346-348. Indeed, Heddebaut teaches that its UWB-transmitters/receivers maintain "in a storage memory the identifiers of the different transmission-reception ultra wide band means of the network." Heddebaut, 5:20-30. This information, stored in local memory, is "*obtained without ranging to wayside units.*" Kain-Decl., ¶348. This information is used to determine the train's position insofar as VOBC uses it to determine the identity of the UWB-transmitters/receivers with which it communicates (*e.g.*, to measure the "distance relative to" to those UWB-transmitters/receivers). *Id.*

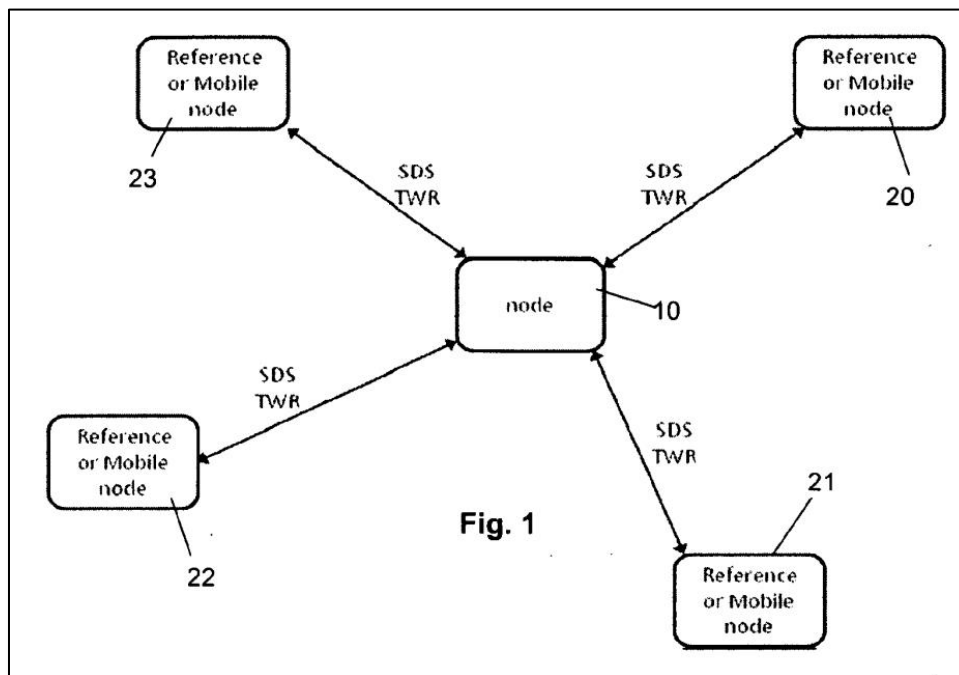
**C. Ground 3: Claims 1-16 Obvious over Carlson and Gantner
Ground 4: Claims 1-14 Obvious Ghaly-Heddebaut and
Gantner**

1. Gantner (EX1007)⁵

Gantner teaches "a Two Way Ranging Procedure" for "a blind node whose position is not known." [0001], [0012], [0063]-[0078]. The blind node determines its position by ranging with "at least one reference or mobile node whose position is known." [0001], [0004], [0071]; Kain-Decl., ¶¶349-351.

⁵ Unless otherwise noted, Section VII.C.1's citations are to Gantner.

Node 10 in Figure 1 below is the blind node, and it determines its location by communicating with “one or several reference or mobile nodes” 20-23. [0002]-[0003]; Kain-Decl., ¶352.



Like the '363 patent (at 15:24-39), Gantner discloses an initiating procedure wherein the blind node “broadcast[s] its identification (ID) within a data packet to all the reference or mobile nodes...in its range.” [0032]. The reference/mobile nodes that receive the blind node’s broadcast then “indicate their presence in response to [the] ID broadcast by the blind node.” [0035]; Kain-Decl., ¶353.

Upon receiving replies from the reference/mobile nodes, the blind node performs ranging with one or more reference/mobile nodes. [0038]. When the blind node receives “more replies than defined in its configuration,” it will “select[]” a subset of responding nodes based on “metrics like RSSI” (received signal strength

indicator). [0038]-[0039]; Kain-Decl., ¶354. For example, 2D localization requires three responding nodes to perform trilateration, and thus the blind node need only select the three reference/mobile nodes with the highest RSSI levels. [0038], [0067]; Kain-Decl., ¶354.

After selecting the one or more reference/mobile nodes, the blind node performs two-way ranging with those node(s). [0041]. With two-way ranging, the blind node sends a data packet to a first-selected node and receives an acknowledgement packet back from it. *Id.* The blind node then calculates “the time required between the transmission of the first data packet and the reception of the acknowledgement packet.” *Id.* This time is then used to “calculate the range (distance) between” the two nodes. *Id.* Kain-Decl., ¶355.

Gantner’s ranging is **two**-way ranging because “a data packet...and an acknowledge packet (Ack) are transmitted between the wireless stations.” [0004]. Thus, like the blind node, the selected node also sends a data packet to the blind node, receives an acknowledgement packet back, and calculates the distance between the two nodes based on the corresponding transmission time. [0041]. The two nodes then share their two distance estimates, and “the average of the two can be used to achieve a fairly accurate distance measurement.” *Id.*; Kain-Decl., ¶356.

Once distance is calculated for all selected nodes, the blind node “is able to define its location relative” to the selected nodes whose location is either “fixed and

known” (reference nodes) or “changing but can be known at a certain time” (mobile nodes). [0054], [0069]-[0070]. Kain-Decl., ¶357.

Gantner discloses that its technique “has several advantages.” [0013]. For example, it allows for two-way ranging “on demand,” *e.g.*, “based on an event at any point in time.” [0016]. It also results “in a simpler infrastructure” because pre-set “synchronization between the reference nodes” is unnecessary. [0015]. It likewise results in a more autonomous system because all processing needed to determine the blind node’s location is done “on board” that node. [0018]; *see also* [0014], [0017] (additional advantages). Kain-Decl., ¶358.

2. The Carlson-Gantner and Ghaly-Heddebaut-Ganter Combinations

POSAs had reasons to implement (1) Carlson’s system such that VMCS 10 used Gantner’s two-way ranging technique, and (2) Ghaly-Heddebaut’s system such that VOBC’s UWB-transmitter/receiver used Gantner’s two-way ranging technique. Kain-Decl., ¶359.

First, Gantner’s two-way ranging technique permits a blind node to determine its location, and POSAs would have recognized that the technique would beneficially allow VMCS 10 or VOBC to determine their respective location when each lacked such information. For example, VMCS 10 may not know its location when the system is first initialized, if it loses its GPS signal in a tunnel, and/or if it loses access to its database of RFID locations. Kain-Decl., ¶360. Likewise, Ghaly-

Heddebaut's VOBC may not know its location when the system is first initialized.
Id.

In these scenarios, Gantner's two-way ranging technique, in which the blind node (*i.e.*, VMCS 10 or the VOBC) broadcasts its ID in a data packet and then selects from a subset of reference/mobile nodes (*i.e.*, reporting stations and other VMCS modules in Carlson-Gantner; UWB-transmitters/receivers located on the track in Ghaly-Heddebaut-Ganter), would have permitted VMCS 10 and/or VOBC to determine its location thereby enhancing system safety. Kain-Decl., ¶361. Implementing Gantner's two-way ranging technique in VMCS 10 and/or VOBC would also have been consistent with Gantner's teaching that the technique is useful as an "on demand" service that can be used "based on an event at any point in time," *e.g.*, points in time when VMCS 10 and/or VOBC lacked up-to-date location information. Gantner, [0016].

Second, apart from solving potential blind-node-type problems in Carlson's system, POSAs separately had reason to implement Gantner's teaching that an initiating node (*i.e.*, VMCS 10 or the VOBC) performing two-way ranging with other nodes (*i.e.*, reporting stations and other VMCS modules in Carlson-Gantner; UWB-transmitters/receivers located on the track in Ghaly-Heddebaut-Ganter) need not perform two-way ranging with all nodes within range and can instead select a subset of such nodes based on, *e.g.*, signal strength. Gantner, [0038]; Kain-Decl.,

¶362. POSAs understood that, all other things equal, RSSI was inversely proportional to distance (*i.e.*, higher RSSI were from closer devices). Kain-Decl., ¶362. POSAs would have therefore recognized the benefit to Carlson's system and/or Ghaly-Heddebaut's system in using metrics like RSSI to select from among responding UWB radios, rather than simply perform ranging with all responding units so that ranging is performed with the closest radios and not performed with radios who are significantly far away. *Id.* Likewise, because positioning can be performed by ranging with as few as one or two devices, selecting the one or two devices with the strongest signal-strength would have been a straight-forward way to pick with which minimally-necessary devices to range. *Id.*

Third, it would have been a simple substitution of one ranging technique (Carlson's non-specified ranging technique and Heddebaut's generic two-way ranging technique) for another (Gantner's more-specific two-way ranging technique) to obtain the predictable result of Carlson's VMCS 10 and/or Ghaly-Heddebaut's VOBC performing ranging using Gantner's two-way ranging technique. *KSR*, 550 U.S. at 417; Kain-Decl., ¶363.

In the Carlson-Gantner and/or Ghaly-Heddebaut-Gantner combinations, Carlson's VMCS and/or Ghaly-Heddebaut's VOBC would have used Gantner's ranging technique to determine their respective speed, location, and relative distance to other UWB radios in their respective systems, *i.e.*, reporting/signal stations and

other VMCS modules in Carlson, and UWB-transmitters/receivers on the tracks in Ghaly-Heddebaut. Kain-Decl., ¶364. All other aspects of Carlson’s system and Ghaly-Heddebaut’s system discussed in Grounds 1 and 2, respectively, would remain unchanged. *Id.*

POSAs would have reasonably expected success in the combination using their ordinary skill because Gantner, Carlson, and Heddebaut disclosed similar ranging techniques. Gantner, [0002] (two-way ranging); Carlson, [0041] (time-of-flight ranging); Heddebaut, 5:49-56 (two-way ranging); Kain-Decl., ¶365. Moreover, Gantner does not restrict its technique to a particular wireless technology, and Carlson and Heddebaut both expressly disclose that their respective UWB-based communication signals could transmit the data used in Gantner’s technique, like an ID of the node desiring its location. Carlson, [0091] (VMCS and reporting stations can “send and receive information” via various wireless techniques), [0132] (“VMCS’s unique ID”); Heddebaut, Abstract; Kain-Decl., ¶365.

Implementing Gantner’s technique in Carlson’s system and/or Ghaly-Heddebaut’s system would have required only ordinary programming skill to configure Carlson’s VMCS 10 and/or Ghaly-Heddebaut’s VOBC to transmit broadcasts and responses, as taught by Gantner. Gantner, [0068] (each node is simply an “element which is capable of transmitting and receiving”), claim 19; Kain-Decl., ¶366.

3. Claim 1

a. [1PRE]-[1D]

Carlson-Gantner and Ghaly-Heddebaut-Ganter meet limitations [1PRE]-[1D] for the same reasons Carlson and Ghaly-Heddebaut, respectively, meet these limitations as discussed above. Kain-Decl., ¶367.

b. [1E]: “wherein obtaining the ranging measurements comprises:

(1) [1E1]: “broadcasting ultra-wideband (UWB) based signals ...”

Carlson-Gantner’s VMCS 10 and Ghaly-Heddebaut-Gantner’s VOBC use Gantner’s two-way ranging technique to obtain ranging measurements using UWB signals. Kain-Decl., ¶368.

Using Gantner’s two-way ranging technique, the VMCS and VOBC would obtain ranging measurements by first “broadcasting its identification (ID) within a data packet to all the reference or mobile nodes in its range.” Gantner, [0032]; *see also* [0019], [0035], FIGS. 3-6, Claim 1 (“Two Way Ranging, TWR, between a blind node ... and to be determined and at least one reference or mobile node”), Claim 2 (“blind node initiates Two Ray Ranging by...broadcasting a data packet”); Kain-Decl., ¶369.

In Carlson-Gantner the reference nodes receiving the broadcast signal are Carlson’s wayside reporting/signal stations and the mobile nodes are VMCS modules on other trains. *Supra* §VII.A.2.d(1); Kain-Decl., ¶370. Similarly, in

Ghaly-Heddebaut-Ganter the reference nodes receiving the broadcast signal are the UWB transmitters/receivers located along the tracks and the mobile nodes are UWB transmitters/receivers located on other intelligent trains. *Supra* §VII.C.2; Heddebaut, 2:8-10 (explaining its UWB system “enabled direct communication between vehicles”); Kain-Decl., ¶¶370-371.

(2) [1E2]: “the UWB based signals comprising information identifying the train-mounted unit”

As discussed *supra* §§VII.A.2.f(2), VII.B.4.f(2), the UWB-based signals broadcast by VMCS 10 in Carlson-Gantner and by VOBC’s UWB-transmitter/receiver in Ghaly-Heddebaut-Gantner includes an “identification (ID)” that identifies the VMCS and/or VOBC. Gantner, [0032], Claim 2 (“blind node ... broadcasting a data packet containing an Identifier ID”). This is consistent with Carlson’s teaching that UWB-signals can include a VMCS’s “unique ID.” Carlson, [0132]. This is also consistent with Heddebaut. Heddebaut, Abstract, 2:19-34, 3:7-12, 4:23-38. It is also a key aspect of Gantner’s two-way ranging which requires that the reference/mobile nodes know to which blind node they are responding. Gantner, [0020] (reference/mobile nodes sends “packet back to the blind node”), [0041]; Kain-Decl., ¶¶172-173.

(3) [1E3]: “selecting based on received responses to the broadcast UWB based signals, one or more of the plurality of wayside units; and

Carlson-Gantner’s VMCS 10 applies Gantner’s ranging technique to select one or more wayside reporting/signal stations based on their responses to the UWB-based broadcast signal, as claimed. Gantner, [0019], [0038]-[0039], [0045], claim 4 (“blind node selects at least one of these reference or mobile nodes for carrying out [two-way-ranging] procedures”). As Gantner taught ([0019], [0039]), selections would be based on metrics, like the RSSI. Kain-Decl., ¶374. For example, VMCS 10 would select only those responsive signals that exceeded a minimum RSSI level so as to exclude distant reporting/signal stations and/or those unnecessary for determining location/speed. Kain-Decl., ¶374.

Similarly, Ghaly-Heddebaut-Gantner’s VOBC uses Gantner’s ranging technique to select one or more UWB-transmitters/receivers along the train track, *i.e.*, wayside, as claimed. Gantner, [0019], [0038]-[0039], [0045], claim 4. As Gantner taught ([0019], [0039]), selections would be based on metrics, like the RSSI, so that, *e.g.*, distant and/or unnecessary reporting/signal stations would be excluded. Kain-Decl., ¶¶375-376.

- (4) [1E4]: “determining ranging information corresponding to each of the one or more wayside units, based on [UWB-signals] communicated respectively with each of the one or more of the plurality of wayside units.”

“After the selection of reference or mobile nodes to be used for” ranging, Carlson-Gantner’s VMCS and/or Ghaly-Heddebaut-Gantner’s VOBC would have performed ranging with each of the one or more selected wayside reporting/signal stations. Gantner, [0040]-[0042] (“procedure is repeated between the blind node 10 and the remaining reference nodes”), FIG. 5, claim 5 (“blind node starts [two-way ranging] procedures with each of the selected reference of mobile nodes”). In Carlson-Gantner and/or Ghaly-Heddebaut-Gantner, ranging is based on UWB-based ranging signals communicated respectively with each of the selected reporting/signal stations (Carlson-Ganter) or UWB-transmitters/receivers on the track (Ghaly-Heddebaut-Gantner), as claimed. Gantner, [0041], claim 4 (“carrying out [two-way-ranging] procedures, respectively” with each node); Kain-Decl., ¶¶377-378.

4. Claims 2-16 (Ground 3)

Carlson-Gantner meets claims 2-16 for the same reasons Carlson discloses or renders obvious those claims, except all UWB-based ranging would have been obtained using the ranging procedures discussed above for limitation [1E]. Kain-Decl., ¶379.

5. Claims 2-14 (Ground 4)

Ghaly-Heddebaut-Gantner meets claims 2-14 for the same reasons Ghaly-Heddebaut renders those claims obvious, except all UWB-based ranging would have been obtained using the ranging procedures discussed above for limitation [1E]. Kain-Decl., ¶380.

VIII. NO BASIS FOR DISCRETIONARY DENIAL

A. Section 314(a)

“[T]he PTAB will not deny institution based on *Fintiv* if there is compelling evidence of unpatentability,” which this Petition provides. Director’s Interim Procedure for Discretionary Denials (June 21, 2022) (“Interim Procedure”). That should conclude the *Fintiv* analysis here. Regardless, the *Fintiv* factors also weigh against discretionary denial.

1. Potential for Stay

This factor is neutral as no stay has been requested. *Apple v. Fintiv*, IPR2020-00019, Paper 15, 12 (May 13, 2020) (informative).

2. Timing of Trial

Petitioners filed this Petition before the district court has ruled on Petitioners’ motions to dismiss and before any procedural schedule (including a trial) has been set. EX1015 (docket). This factor thus weighs against the Board discretionarily denying institution. *Samsung Elecs. v. Netlist*, IPR2022-00063, Paper 13, 8 (May 5, 2022).

3. Litigation Investment

Other than initial motion practice, the parties have invested little in the district court litigation. This factor thus also weighs against discretionary denial. *Id.*

4. Overlap of Issues

Given Petitioners' filing here before any substantive district court activity, the validity issues in the litigation are unknown. Here, Petitioners challenge all 16 claims of the '363 patent, whereas patent owner has asserted only a subset of those claims in district court. EX1016, 24-34. A trial before the Board will thus address claims that the district court will not address, which weighs against discretionary denial. *Markforged v. Continuous Composites*, IPR2022-00679, Paper 7, 32-33 (Oct. 25, 2022).

5. Litigation Defendants

Although Petitioners are litigation defendants, the fact that no trial date has been set means this factor weighs against discretionary denial. *Samsung Elecs.*, IPR2022-00063, Paper 13, 8.

6. Other Circumstances

The Petition's "strong showing on the merits" weighs against denial. Interim Procedure, 3-5.

B. Section 325(d)

Under *Advanced Bionics v. Med-El*, IPR2019-01469, Paper 6 (Feb. 13, 2020) (precedential), the Board considers whether the Petition presents the

same/substantially the same art/argument previously presented and, if so, whether it shows that the Office materially erred in its prior evaluation.

1. Step 1: The Petition Advances Art and Arguments Not Previously Considered

Though Carlson and Heddebaut were cited in an IDS (EX1002, 79, 556), neither was applied as a basis for rejection. The Petition's argument that Carlson anticipates and/or renders obvious claim 1-16 and that Ghaly⁶-Heddebaut renders claims 1-14 obvious has thus not been considered previously by the Office. Step 1 therefore is not satisfied.

2. Step 2: The Office Erred Materially

If Step 1 is satisfied merely because Carlson and Heddebaut were cited in an IDS, discretionary denial is still unwarranted because the Office erred materially in its prior "evaluation." Step 2 focuses on *Becton, Dickinson* factors (c), (e), and (f) (*Advanced Bionics*, 10), which all weigh against denial.

a. Factor (c): Carlson Was Not Previously Evaluated

During prosecution, Carlson and Heddebaut were only cited in an IDS (EX1002, 80). The Board has "consistently held that a reference that was neither applied against the claims nor discussed by the examiner," like Carlson and

⁶ Other Ghaly references were cited in an IDS (EX1002, 76-77), but they too were not the basis of a rejection.

Heddebaut, “does not weigh in favor of exercising our discretion under § 325(d).”
Bowtech v. MCP IP, IPR2019-00382, Paper 12, 12 (Aug. 6, 2019).

Petitioners are not asking the Office to reconsider any arguments regarding claims 1-16; here, ***for the first time***, they are asking the Office to consider whether Carlson anticipates those claims and/or Ghaly-Heddebaut renders those claims obvious.

b. Factors (e)-(f): The Office Erred

Where “the Office’s previous consideration of the art is not well developed or silent,” as here, “then a petitioner may show the Office erred by overlooking something persuasive.” *Advanced Bionics*, 10.

The Petition details how Carlson anticipates and/or renders obvious claims 1-16, and how Ghaly-Heddebaut separately render claims 1-14 obvious. This is “something persuasive” that the Office overlooked when it allowed the claims despite being aware of Carlson and Heddebaut.

IX. CONCLUSION

The Board should institute this IPR.

Dated: 01-10-2023

Respectfully submitted,

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CERTIFICATE OF SERVICE UNDER 37 C.F.R. § 42.6 (E)(4)

I certify that on January 10, 2023, I will cause a copy of the foregoing document, including any exhibits or appendices filed therewith, to be served via Overnight FedEx at the following correspondence address of record for the patent:

McAndrews Held & Malloy, Ltd
500 West Madison Street
Suite 3400
Chicago, IL 60661

Date: January 10, 2023

/MacAulay Rush/
MacAulay Rush
Paralegal
WOLF, GREENFIELD & SACKS, P.C.

CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24, the undersigned certifies that the foregoing IPR petition contains 13,999 words excluding a table of contents, a table of authorities, Mandatory Notices under § 42.8, a certificate of service or word count, or appendix of exhibits or claim listing. Petitioners have relied on the word count feature of the word processing system used to create this paper in making this certification.

Date: January 10, 2023

/MacAulay Rush/
MacAulay Rush
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WOLF, GREENFIELD & SACKS, P.C.

X. CLAIM LISTING

The following claim listing assigns element labels (*e.g.*, [1A1], [1A2], etc.) to certain claims for clarity.

Claim 1
[1PRE] A system for providing decentralized control operations in a railway network, the system comprises:
[1A] a plurality of wayside units, each configured for placement on or near tracks in the railway network; and
[1B] one or more train-mounted units, each configured for deployment on a train operating in the railway network;
[1C] wherein each train-mounted unit is configured to:
[1C1] communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals; and
[1C2] generate based on the communication, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network,
[1D] wherein generating the control information comprises or is based on obtaining ranging measurements, and
[1E] wherein obtaining the ranging measurements comprises:
[1E1] broadcasting ultra-wideband (UWB) based signals within a wireless range of the train-mounted unit,
[1E2] the UWB based signals comprising information identifying the train-mounted unit;
[1E3] selecting based on received responses to the broadcast UWB based signals, one or more of the plurality of wayside units; and
[1E4] determining ranging information corresponding to each of the one or more wayside units, based on ultra-wideband (UWB) based signals communicated respectively with each of the one or more of the plurality of wayside units.

Claim 2

The system of claim 1, wherein the train-mounted unit is configured to generate at least part of the control information based on sources other than processing of the ultra-wideband (UWB) based signals.

Claim 3

[3A] The system of claim 2, wherein the train-mounted unit is configured to: assess based on the processing of the ultra-wideband (UWB) based signals, one or more conditions relating to operation of the train within the railway network;

[3B] when at least one condition meets one or more particular criteria, determine one or more responsive actions;

[3C] and perform or cause performing each of the one or more responsive actions.

Claim 4

The system of claim 3, wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator,

[4B] the train-mounted unit is configured to: monitor actions of the train operator;

[4C] assess based on the monitoring, the train operator's compliance with at least one expected subsequent responsive action; and

[4D] when the train operator fails to do so, directly perform the at least one expected subsequent responsive action or perform an alternative action.

Claim 5

The system of claim 1, wherein the train-mounted unit is configured for utilizing non-UWB based signals for communicating at least some data with the wayside unit and/or another train-mounted unit.

Claim 6

The system of claim 1, wherein the train-mounted unit is configured for handling radio-frequency identification (RFID) based signals with RFID devices used within the railway network.

Claim 7

The system of claim 1, wherein the train-mounted unit is configured for handling satellite based signals.

Claim 8

The system of claim 7, wherein the train-mounted unit is configured for obtaining from received satellite based signals information, and generating or adjusting the control information based on the obtained information.

Claim 9
The system of claim 1, wherein the train-mounted unit is configured for connecting to and/or interfacing with other systems of the train.
Claim 10
The system of claim 1, comprising one or more input/output (I/O) components, for receiving input from an operator of the train and/or for providing output to the operator of the train.
Claim 11
The system of claim 1, comprising a power component for supplying and/or obtaining power for components of the train-mounted unit.
Claim 12
The system of claim 1, wherein the train-mounted unit is configured for communicating, directly or via at least one of the wayside unit and another train-mounted unit, with one or more other components or devices in the railway network, the one or more other components or devices in the railway network not being part of decentralized train control system.
Claim 13
The system of claim 1, wherein the train-mounted unit is configured to substantially continually determine absolute position of the train, based on the ranging information obtained from ranging with wayside units.
Claim 14
The system of claim 13, wherein the train-mounted unit is configured to determine the absolute position of the train based on the ranging information and positioning information obtained without ranging to wayside units.
Claim 15
The system of claim 14, wherein the train-mounted unit is configured to obtain at least portion of the positioning information from each wayside unit as the train passes the wayside unit.
Claim 16
The system of claim 15, wherein the train-mounted unit is configured to obtain at least portion of the positioning information from at least one wayside unit as the train passes that wayside unit using non-UWB communications.