

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HUM INDUSTRIAL TECHNOLOGY, INC.,
Petitioner,

v.

AMSTED RAIL COMPANY, INC.,
Patent Owner.

IPR2023-00539
Patent 9,981,673 B2

Before JAMES P. CALVE, KEVIN W. CHERRY, and
MICHAEL L. WOODS, *Administrative Patent Judges*.

CALVE, *Administrative Patent Judge*.

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

I. BACKGROUND

Hum Industrial Technology, Inc. (“Petitioner”) filed a petition requesting *inter partes* review of claims 1–18 and 20–22 (the “challenged claims”) of U.S. Patent No. 9,981,673 B2 (“the ’673 patent”) (Ex. 1001). Paper 1, 5 (“Pet.”). Amsted Rail Company, Inc. (“Patent Owner”) timely filed a Preliminary Response. Paper 6 (“Prelim. Resp.”).

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

A. Related Proceedings

The parties identify the following litigation involving the ’673 patent: *Amsted Rail Company, Inc. v. Hum Industrial Technology, Inc.*, Case No. 4:22-cv-00445-AGF (E.D. Mo.). Pet. 2; Paper 5, 2. Petitioner has requested the following *inter partes* reviews of patents owned by Patent Owner: (1) IPR2023-00538 for U.S. Patent No. 9,365,223 B2 and (2) IPR2023-00540 for U.S. Patent No. 10,137,915 B2. Paper 5, 2; see Pet. 2

B. Real Parties in Interest

Petitioner identifies Hum Industrial Technology, Inc. and Dr. Brent Wilson, an employee of Hum, as real parties-in-interest. Pet. 1. Patent Owner identifies Amsted Rail Company, Inc., Amsted Digital Solutions, Inc., and IONX LLC as the real parties-in-interest. Paper 5, 1.

C. The '673 patent (Ex. 1001)

The '673 patent attaches sensors to railcars to monitor components, detect deviations or trends from nominal operating parameters, and warn of actual or impending failures. Ex. 1001, 1:15–22, 2:3–33. Communication management units (CMUs) collect data wirelessly from sensors and analyze it using heuristics and statistical models to generate results that are sent to a locomotive or station remote from the railcar. *Id.* at 2:61–3:20, 8:13–11:58.

The CMU can generate alarms based on trending conditions, bearing temperatures relative to temperatures of other bearings or relative to ambient temperatures, bearing temperatures above a predetermined temperature, and bearing temperatures that deviate from average bearing temperatures of a wagon or fleet or from a predetermined temperature. Ex. 1001, 13:8–15:45.

The '673 patent issues different alarm levels based on severity and appropriate responses. Ex. 1001, 13:30–14:3. A Bearing Temp Alarm is sent to a base station for trending recommendations and repeat offenders. An Axle Differential Alarm issues for bearing temperatures hotter than an axle mate by a predetermined amount, and the train is stopped to check a bearing journal. An Above Ambient Alarm issues when a bearing is a predetermined amount above ambient, and the train is stopped to check a bearing journal. A Critical Alarm issues for bearing temperatures above a predetermined temperature, and the train is stopped to remove a bearing. *Id.*

D. Challenged Claims

Petitioner challenges claims 1–18 and 20–22 of the ’673 patent. *See* Pet. 5. Claims 1, 10, 14, and 21 are independent. Claims 2–9 and 13 depend from claim 1. Claims 11 and 12 depend from claim 10. Claims 15–18 and 20 depend from claim 14. Claim 22 depends from claim 21. Ex. 1001, 15:62–18:27 (the ’673 patent claims). Claim 1 is reproduced below, reformatted from the ’673 patent with Petitioner’s annotations added in italics to identify each limitation:

- 1 *Preamble* A method of monitoring operational characteristics of a railcar comprising the steps of:
- 1(a)* a. receiving data or processed information regarding said operational characteristic from one or more sensing units on said railcar, said sensing units monitoring an operational characteristic of said railcar;
 - 1(b)* b. applying a heuristic to said received data to determine deviations from nominal operating conditions;
 - 1(c)* c. assigning a severity level to said deviations from nominal operating conditions; and
 - 1(a)* d. determining an alarm condition based on said assigned severity level.

Ex. 1001, 15:62–16:6; *see* Pet. ix (Listing of Claims).¹

E. Asserted Grounds of Unpatentability

Petitioner asserts that the challenged claims are unpatentable on the following four grounds (Pet. 6):

¹ We adopt Petitioner’s designations of claim elements of the challenged claims. Pet. 18–77 (grounds of unpatentability), ix–xiii (Listing of Claims).

Ground	Challenged Claim(s)	35 U.S.C. §	Reference(s)
1	1–7, 10–18, 20–22	103(a) ²	LeFebvre ³
2	8, 9	103(a)	LeFebvre, Barone ⁴
3	1, 2, 4, 6–11, 13	103(a)	Armitage ⁵
4	3, 5, 12–18, 20–22	103(a)	Armitage, LeFebvre

Petitioner relies on a Declaration of Steven Ricca. Ex. 1003. Patent Owner relies on a Declaration of Michael I. Shamos, Ph.D. Ex. 2001.

II. DISCUSSION

A. Level of Ordinary Skill in the Art

Petitioner asserts that a person of ordinary skill in the art “would have been a person with at least a B.S. degree in electrical or mechanical engineering or a related field with at least two years’ experience designing monitoring systems for railcar components, or monitoring systems for similar industrial equipment with rotating components,” and “[l]ess work experience could be compensated by a higher level of education, such as a master’s degree, and vice versa.” Pet. 14 (citing Ex. 1003 ¶ 45).

² The Leahy-Smith America Invents Act (“AIA”) included revisions to 35 U.S.C. § 103 that became effective on March 16, 2013. Changes made to 35 U.S.C. § 103 in the AIA do not apply to any application for patent filed before March 16, 2013. Because the ’673 patent has an effective filing date before March 16, 2013, we refer to the pre-AIA versions of § 103.

³ US 2007/0152107 A1, published July 5, 2007 (Ex. 1005, “LeFebvre”).

⁴ US 2007/0208841 A1, published Sept. 6, 2007 (Ex. 1007, “Barone”).

⁵ US 2011/028540 A1, published Nov. 17, 2011 (Ex. 1006, “Armitage”).

Patent Owner contends that a skilled artisan “is a person with at least a B.S. degree in electrical or computer science or a related field, with at least two years’ experience with sensing systems for railcars or similar industrial equipment, including familiarity with wireless networks and heuristics and statistical data analysis for failure prediction,” and “[l]ess work experience could be compensated for by a higher level of relevant education and vice versa.” Prelim. Resp. 9 (citing Ex. 2001 ¶¶ 36–40).

We adopt Patent Owner’s proposed level as more consistent with the ’673 patent and prior art, but our analysis is the same under either proposal.

B. Claim Interpretation

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

Petitioner asserts that the claims should be given their plain and ordinary meaning. Pet. 15. Patent Owner proposes constructions for “a heuristic” and “heuristically analyzing,” “nominal operating conditions,” and “severity level.” Prelim. Resp. 10–12. For this Decision, we give the claims their plain and ordinary meaning.

1. “heuristic” and “heuristically analyzing”

The parties appear to agree that a “heuristic” is a rule applied to data to assist in drawing conclusions or inferences from that data. Prelim. Resp. 10 (Patent Owner’s proposed construction of “one or more rules”), 26 (citing Petitioner’s proposed construction in district court litigation of “one or more rules to be applied to data to assist in drawing inferences from said data”).

An ordinary meaning of “heuristic” is “involving or serving as an aid to learning, discovery, or problem-solving by experimental and especially trial-and-error methods.” Merriam-Webster.com at “<http://www.merriam-webster.com/dictionary/heuristic>” (accessed June 12, 2023) (Ex. 3001).

Heuristics in the ’673 patent are (1) empirical data used to correlate sensed bearing adapter temperature to bearing temperature, (2) correlating sensed pressure in a trainline to brake pressure, (3) converting bolster/side frame displacement to load, (4) estimating a temperature of tank contents from inner jacket temperature, (5) using dynamic bearing data at an adapter with a fast Fourier transform (FFT) algorithm to isolate dominant modes, and amplify at rolling frequency to indicate faults, (6) converting radial acceleration to vehicle speed using dynamics and wheel and axle diameters, (7) using dynamic bearing data at an adapter and kurtosis in a time domain with a probability density function to indicate bearing damage, (8) applying a probability density function and kurtosis to dynamic data at a bearing adapter and other truck components to indicate track defects, (9) using a simple FFT algorithm with data from adapters to isolate known hunting frequencies or detect flange impacts to identify hunting, and (10) correlate wheel temperature to tread temperature using empirical data. Ex. 1001, 8:20–12:39 (chart of sensed parameter, sensor type, output, and heuristic).

Interpreted in light of the '673 patent specification, a “heuristic” is a rule, algorithm, function, formula, graphing function, or similar mechanism applied to data to assist in analyzing and/or interpreting the data.

2. *“nominal operating conditions”*

Patent Owner argues that “nominal operating conditions” should mean “expected operating conditions.” Prelim. Resp. 11. This term appears only in the Background of Invention and claims. Ex. 1001, 2:3–6, 16:1–27.

The '673 patent relates to systems that apply heuristics to sensor data “to detect operational deviations or trends which show deviations from nominal operating parameters.” *See id.* at 2:3–6. Alarms are generated for deviations from operating conditions identified by trends and deviations of sensed bearing temperatures from temperatures of other bearings on the same axle, same wagon, or same fleet. *Id.* at 13:30–15:36. Alarms may be generated when a bearing temperature exceeds an ambient temperature or a threshold by a preset amount. *Id.* at 13:49–67, 14:1–30.

We thus interpret “nominal operating conditions” to mean “normative or expected conditions based on trends, conditions of other components, ambient conditions, and predetermined values.”

3. *“severity level”*

Patent Owner argues that “severity level” means “assigning one from a plurality of known values indicating seriousness.” Prelim. Resp. 11. We interpret “severity level” as “a type of fault that requires a particular action.” A bearing temperature exceeding a threshold, an ambient temperature, or a temperature of other bearings a certain percentage of times or by a certain amount (deviation) is flagged for maintenance, immediate inspection by a train crew, or possible replacement. Ex. 1001, 13:9–15:46.

C. Prosecution History of the '673 patent

In response to a traversal of the first Office Action (Ex. 1002, 106–120, 419–434), the Examiner issued a Notice of Allowability for all claims because the prior art did not render obvious “a control method applying a heuristic to said received data to determine deviations from nominal operating conditions; assigning a severity level to said deviations from nominal operating conditions; and determining an alarm condition based on said assigned severity level” (*id.* at 488–495).

D. Principles of Law

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

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

E. Ground 1: Alleged Obviousness Over LeFebvre

Petitioner asserts claims 1–7, 10–18, and 20–22 are unpatentable under § 103 over LeFebvre, because LeFebvre does not disclose expressly all limitations as part of a single embodiment. *See* Pet. 6, 18–41.

1. LeFebvre (Ex. 1005)

LeFebvre's system uses pads 16 with sensors 5 on bearing adapters 4 to measure loads and heat transmitted by axle bearing 2a through adapters 4 and transmit indications of fault or impending failure that pads 16 detect to a data control unit 23 on each railcar. Ex. 1005 ¶¶ 18–21, 33–36, Figs. 3, 4.

LeFebvre applies heuristics to sensor data via an inference engine of search algorithms distributed between pads 16 and data control unit 23 to process sensor data to identify indications of fault, impending failure, and unsatisfactory behavior. Ex. 1005 ¶¶ 33–37, 53–66. The inference engine can identify periodicities and cross correlations in data to identify deviations from expected operating conditions such as changing loads and distributions at frequencies that indicate car hunting, swaying, or rocking for particular truck geometry and wheel rotation speed or repetitive patterns of forces at rotation frequencies that indicate wheel irregularities. *Id.* ¶¶ 54, 62.

Specific bearing defects can be inferred from long term trends, alarm thresholds, temperatures of other bearings, and frequency spectrum analysis of vibrations emitted by bearings. *Id.* ¶¶ 58, 59.

Different levels (types) of faults and deviations result in different responses. Specific bearing defects result in preventative maintenance while certain wheel defects result in a wheel change out. *Id.* ¶¶ 59, 60. Wheel set derailment and bearing adapter displacement are repaired. *Id.* ¶¶ 61, 64.

2. Independent Claim 1

Regarding the preamble, Petitioner contends that LeFebvre discloses a system for monitoring railroad trains by using an instrumented roller bearing adapter pad to detect the occurrence and cause of poor performance at wheel set, truck, freight car, or train level. Pet. 18–19 (citing Ex. 1005 ¶ 1). This contention, which Patent Owner does not contest at this stage, is supported sufficiently by evidence of record.

Regarding element 1(a), Petitioner contends that LeFebvre discloses a data control unit 23 mounted on a railcar to receive data from pads 16 with “sensing units” (sensors) mounted on a wheel bearing adapter to measure the operational parameters of the railcar such as temperature and communicate the data to data control unit 23. Pet. 19–21 (citing Ex. 1005, Abstract, ¶¶ 19, 21, 23, 24, 33, 39, 52, 58, Figs. 4, 5; Ex. 1003 ¶ 72–75). This contention, which Patent Owner does not contest at this stage, is supported sufficiently by evidence of record. Instrumented pads 16 gather readings from sensors 5 periodically, perform preliminary analysis, and send alarm messages to data control unit 23 when indications of fault or impending failure are detected from any of the sensors, which measure dynamic and static vertical loads, shear or lateral forces, and temperature. Ex. 1005 ¶¶ 33–35, 52–56.

Regarding element 1(b), Petitioner contends that data control unit 23 applies “inference engine techniques” as heuristics to analyze data received from instrumented pads 16, compare information from all the trucks on the railcar, and draw inferences regarding the status of the freight car to identify unsatisfactory behavior such as swaying, bouncing, and derailment for the whole truck and ultimately the freight car. Pet. 21 (citing Ex. 1005 ¶¶ 36, 56, 95; Ex. 1003 ¶ 77).

Petitioner asserts that LeFebvre applies heuristics to collected data to infer numerous conditions including bearing defects, wheel defects, wheel derailment, truck hunting, displaced roller bearing adapters, and brake status and performance, e.g., derailment from high frequency repeated loads at the wheels in a wheel set, track defects from vertical loads, and brake problems from very high or low brake loads. *Id.* at 21–22 (citing Ex. 1005 ¶¶ 58–62, 64–66; Ex. 1003 ¶¶ 77, 79).

Patent Owner argues that LeFebvre does not apply a heuristic to the received data to determine deviations from nominal operating conditions, as claimed, because data control unit 23 aggregates sensor data to determine unsatisfactory behavior by comparative analysis of data from all trucks on a railcar. Prelim. Resp. 33. Patent Owner asserts, “a [skilled artisan] would understand that, in the context of claim 1, ‘a heuristic’ means ‘one or more rules’ and the phrase ‘deviations from nominal operating conditions’ means ‘deviations from expected operating conditions.’” *Id.* at 33–34. Patent Owner argues that the comparison operation in paragraph 36 of LeFebvre “does not involve comparing sensor data for an operational characteristic of a component to expected operating parameters for that component, and does not apply heuristics to determine a deviation between a sensed operating characteristic and an expected operating condition” because LeFebvre “aggregates sensor data from a plurality of sensors and compares individual sensor data against the aggregated sensor data to identify specific sensors that are behaving ‘sufficiently poorly’ relative to the other sensors.” *Id.* at 34. Patent Owner asserts, “LeFebvre can only detect relative deviations with respect to the performance of other bearings, not expected operation conditions.” *Id.* at 34 (citing Ex. 2001 ¶¶ 52–54).

LeFebvre's inference engine uses algorithms (heuristics) to identify periodicities or cross correlations in time series data that may indicate *unsatisfactory behavior of sufficient magnitude* to be a "fault" and generate an alarm. Ex. 1005 ¶¶ 33–36, 52–66. The system processes raw sensor data for signs of trouble and sends only essential indicative information. *Id.* ¶ 53.

Heuristic inference engine algorithms are used to correlate sensor data to frequencies or other operating conditions that are compared to thresholds to identify deviations from normal operating conditions. Ex. 1005 ¶¶ 33–36, 52–66, 95. Data control unit 23 applies inference engine heuristics to changing loads measured at pads 16, e.g., vertical, shear, and/or braking forces, to determine a *frequency* at which a truck moves back and forth across a rail and identify truck or axle "hunting" if this *frequency* relates to a railcar operational characteristic such as truck hunting threshold or warp for its truck geometry and wheel rotation. *See id.* ¶¶ 54, 62.

Data control unit 23 analyzes changing loads and load distributions of vertical, shear, and braking forces to determine *frequencies* used to identify swaying and rocking of a railcar when the frequencies correlate to mass spring systems of suspension thresholds indicative of swaying and rocking rather than nominal, expected operating conditions. *See id.* ¶¶ 54, 62, 95.

Wheel irregularities can create repetitive patterns of forces deviating from expected conditions at a rotation frequency threshold correlated for a vehicle's calculated speed. Ex. 1005 ¶ 54. Track defects generate large, sudden forces in wheels, bearings, and trucks at magnitude thresholds that deviate from expected operating conditions, and data control unit 23 may compare unexpected vertical loads in wheel sets to one another to identify other types of track defects. *Id.* ¶¶ 54, 55, 66, 95; Pet. 22.

Longitudinal, lateral, and yawing forces can be analyzed to determine deviations of the angle of attack of wheel sets from expected, normal angles of attack to identify high rotational friction caused by binding side bearings or dry center bowls to prevent damage to freight car trucks. Ex. 1005 ¶ 62.

Data control unit 23 analyzes loads measured in instrumented pads 16 on a freight car to determine its weight and to detect load imbalances due to improper loading or shifting in transit that deviate from normal, expected operating conditions (load distributions) of balanced loads. Ex. 1005 ¶ 63.

Monitoring loads in instrumented pad legs allows data control unit to identify displaced roller bearing adapters so an alarm for urgent maintenance can be made to avoid damage to the roller bearing. Ex. 1005 ¶¶ 64, 95.

High amplitude, repeated loads that repeat periodically, correlate to wheel diameter and speed, and deviations from expected conditions can identify flat and shelled wheel treads, and higher frequency high loads in both wheels of a set can identify derailments when they are outside expected operating conditions. Ex. 1005 ¶¶ 60, 61, 95; Pet. 22; Ex. 1003 ¶ 79.

Data control unit 23 monitors longitudinal forces measured at pads and correlates this sensor data to forces applied by brake pads to wheels to determine braking efficiency and identify excessively high or excessively low applied brake loads that deviate from expected braking conditions or indicate handbrakes are applied. Ex. 1005 ¶¶ 65, 95. The unit can send an alarm if a train is moved with some handbrakes applied, which should not occur in normal operating conditions. *Id.* ¶ 65.

When heuristically-processed sensor data detects conditions that deviate from nominal operating values, data control unit 23 reports a fault or alarm to a central station and/or a locomotive. Ex. 1005 ¶¶ 38, 52, 56, 95.

The '673 patent describes similar heuristics that determine deviations from nominal operating conditions. Truck hunting is identified by sampling dynamic sensor data from a bearing adapter and using algorithms to isolate known hunting frequencies or flange impacts. Ex. 1001, 11:1–20; *cf.* Ex. 1005 ¶¶ 54 (truck hunting frequencies), 62 (truck hunting loads).

Truck tilt angles are correlated to sensor data that measures roll, pitch, and yaw angles. Ex. 1001, 11:28–35; *cf.* Ex. 1005 ¶ 62 (longitudinal, lateral, yawing forces correlated to warp and hunting).

Trainline pressure is correlated to brake pressure and strain gauge data identifies whether a handbrake is on or off. Ex. 1001, 8:29–35; *cf.* Ex. 1005 ¶ 65 (correlate longitudinal force applied by brake pads to wheels to identify excessively high or low brake loads and whether a handbrake is on).

Sensor measurements of bolster/side displacement are converted to load using a spring stiffness heuristic to determine the car load and whether the car is empty or full. Ex. 1001, 8:36–46. Load sensor data on trucks is analyzed with heuristics to determine car load. *Id.* at 11:24–25; *cf.*, Ex. 1005 ¶ 63 (sensed loads correlated to weight and load imbalances).

Data from sensors on adapters and trucks is analyzed to identify track defects. Ex. 1001, 9:50–11:5; *cf.* Ex. 1005 ¶¶ 54 (large, sudden forces in wheels, bearings, and trucks processed by inference engine to detect track defects), 66 (monitor vertical loads in pads, compare between wheel sets).

Wheel temperature is correlated to tread temperature using empirical data. Ex. 1001, 11:20–25; *cf.* Ex. 1005 ¶ 58 (bearing temperature compared to alarm levels and other bearings). Bearing faults and defects are identified at selected frequencies from sensor data. Ex. 1001, 9:26–44; *cf.* Ex. 1005 ¶ 59 (monitor vibrations, detect bearing defects from frequency analysis).

The '673 patent also determines deviations from expected operating conditions by comparing sensed data of a part to sensed data of another part or condition. When a bearing temperature is a predetermined amount higher than its axle mate's temperature, an axle differential alarm occurs. Ex. 1001, 13:12–39. When bearing temperatures over a time period exceed ambient temperature by a defined value, or exceed an average bearing temperature of a wagon or fleet over a period, an alert may be sent. Ex. 1001, 14:10–15:46.

LeFebvre compares bearing temperatures to identify deviations from expected conditions. Ex. 1005 ¶ 58. If a difference between temperatures of bearings exceeds an alarm threshold, an alarm is issued. *Id.* If a bearing temperature exceeds an alarm level, an alarm is issued. *Id.* Data control unit 23 determines if the freight car, its trucks, wheels, or axles “are behaving sufficiently poorly” that a report should be made to a central data handling location, owner, operator, or locomotive. *Id.* ¶ 95; Ex. 1003 ¶ 79.

In short, LeFebvre's inference engine uses algorithm heuristics to convert or correlate data measured at instrumented pads 16 to operating conditions (e.g., loads, frequencies, forces) that are compared to thresholds and alarm levels to identify deviations from expected operating conditions. Such deviations can identify hunting, swaying, and rocking of a car, wheel problems, bearing faults, and actual or potential failures. Ex. 1005 ¶¶ 33–36, 52–66, 95; *see* Pet. 21–22; Ex. 1003 ¶¶ 78, 79. Instrumented pads 16 report misbehavior when sensed data deviates from expected conditions with enough *magnitude* to cause alarm. Ex. 1005 ¶¶ 55, 56. Data control unit 23 determines if a freight car, trucks, wheels, or axles “are *behaving sufficiently poorly* that a report to the central data handling location or owner or operator or locomotive is needed.” *Id.* ¶ 95 (emphasis added); *see* Ex. 1003 ¶ 79.

Dr. Shamos avers that LeFebvre does not compare operational aspects to expected parameters or use heuristics to determine a deviation but instead compares individual sensors to aggregated sensor data to identify parts that behave sufficiently poorly. Ex. 2001 ¶¶ 53 (citing Ex. 1005 ¶¶ 36, 95), 54; Prelim. Resp. 33–34. Yet, LeFebvre receives sensing data for operational characteristics of a railcar as claimed. The ’673 patent determines faults by comparing a bearing’s temperature to temperatures of an axle mate, a fleet average, a wagon average, or ambient conditions. Ex. 1001, 13:7–15:46.

Dr. Shamos does not address LeFebvre’s use of an inference engine to identify deviations from threshold frequencies, loads, and other values, as discussed. Ex. 1005 ¶¶ 33–36, 52–66, 95; *see* Pet. 21–22 (citing Ex. 1005 ¶¶ 56–62, 64–66); Ex. 1003 ¶ 79 (citing Ex. 1005 ¶¶ 58–62, 64–66).

Regarding element 1(c), Petitioner contends that LeFebvre assigns a severity level to deviations by pads reporting errors to a data control unit if a deviation’s “magnitude is sufficient to cause alarm,” or a data control unit determines that components are behaving sufficiently poorly to send a report to a central data handling location, operator, or locomotive. Pet. 22–23 (citing Ex. 1005 ¶¶ 55, 95, claims 9, 12, 21, 28; Ex. 1003 ¶¶ 80–83).

Regarding element 1(d), Petitioner contends that LeFebvre’s system uses the data control unit to determine whether an alarm message should be generated and the data control unit uses the inference engine to check if the freight car, its trucks, wheels, or axles are behaving sufficiently poorly that a report should be sent to the central data handling, owner, operator, or the locomotive. Pet. 24. Petitioner asserts that the detected condition must be sufficiently severe for an alarm message to be warranted and sent upstream. *Id.* (citing Ex. 1005 ¶¶ 56, 95; Ex. 1003 ¶¶ 84–86).

Patent Owner argues that LeFebvre does not assign a severity level to deviations from nominal operating conditions or determine alarm conditions based on a severity level, because assigning a severity level means assigning one of a plurality of known values indicating seriousness. Prelim. Resp. 34–35. Patent Owner asserts that LeFebvre issues an alarm if the magnitude is sufficient and no alarm if the single threshold is not exceeded. *Id.* at 35.

The '673 patent describes (1) alarms sent to a base station, (2) alarms sent to a locomotive to check bearing journals, and (3) alarms to stop a train and *change a bearing*, (4) alerts sent to customers to *schedule maintenance* for a bearing. Ex. 1001, 13:30–14:65. Alarms are generated by comparing sensed values to trends, values of other components, ambient conditions, and thresholds. *Id.* at 2:3–6, 12:40–14:3, 14:10–65.

LeFebvre sends alarms to locomotives, a central data handling site, an owner, or operator based on the severity level, i.e., how poorly a component is behaving. Ex. 1005 ¶¶ 52, 95; Pet. 24. When serious trouble is inferred, messages are sent to a locomotive. Ex. 1005 ¶ 56. Different conditions cause different alarms. Bearing temperatures above other bearings, long term trends, or alarm levels *are addressed* to avoid a burnoff. *Id.* ¶ 58. Failing bearings result in *preventative maintenance*. *Id.* ¶ 59. Wheel defects result in *wheel changes*. *Id.* ¶ 60. A *derailed wheel set* is *fixed* to prevent full derailment. *Id.* ¶ 61. Hunting, warp, and angle of attack alarms suggest *fixing binding bearings* or *dry center bowls*. *Id.* ¶ 62. A displaced rolling bearing adapter requires *urgent maintenance*. *Id.* ¶ 64. When a component behaves sufficiently poorly, *a report is sent* to a (1) central data handling location, (2) owner, (3) operator, and/or (4) locomotive. Pet. 22–23 (citing Ex. 1005 ¶¶ 55, 95, claims 9, 12, 21, 28; Ex. 1003 ¶¶ 82–86).

We conclude on the present record that Petitioner has established a reasonable likelihood that claim 1 would be unpatentable over LeFebvre.

3. Dependent Claims 2–7 and 13

Petitioner contends that LeFebvre establishes wireless communication with remote sensing units (claim 2) forming a mesh network (claim 3), steps a–d of claim 1 are executed by a processing unit on the railcar (claim 4) that is part of the mesh network (claim 5), the alarm condition is transmitted to a location remote from the railcar (claim 6), data received from one or more sensing units is transmitted to a remote location (claim 7), and inference engines are distributed across pads and data control unit (claim 13). Pet. 24–28 (citing contentions for elements 1(a)–1(d); Ex. 1005 ¶¶ 24, 31, 32, 39, Fig. 5; Ex. 1003 ¶¶ 87–99), 33–34. These contentions, which Patent Owner does not contest at this stage, are supported sufficiently by record evidence.

LeFebvre’s instrumented pads 16 have sensors 5, microprocessor 19, communications unit 20, and antenna 21 to communicate wireless messages via short range radio to data control units 23. Ex. 1005 ¶¶ 24, 31, 35. The remote sensing units (pads 16) form a mesh network that passes messages between pads to and from data control unit 23 on a railcar. *Id.* ¶¶ 24, 31, 39, Fig. 1. Data control unit 23 transmits alarms to a location remote from the rail car such as a locomotive or a central data handling location and serves as a conduit to pass messages to communication device 24 to transmit to the locomotive or remote receivers. *Id.* ¶¶ 25, 31, 38, 52, 55, 95. Inference engines in pads 16 and data control unit 23 analyze sensor data heuristically to identify deviations and alarm conditions. *Id.* ¶¶ 33–36, 52–66, 96. We conclude on the present record that Petitioner has established a reasonable likelihood that claims 2–7 and 13 are unpatentable over LeFebvre.

4. *Independent Claim 10 and Claims 11 and 12*

Regarding claim 10, Petitioner contends that LeFebvre discloses elements 10 Preamble, 10(a), and 10(b) by monitoring temperatures of a wheel bearing associated with an instrumented pad by using instrumented pad 16 and its temperature sensor(s) to measure the temperature of wheel bearing adapter 4 from which the temperature of wheel bearing 2a can be inferred. Pet. 28–30 (citing Ex. 1005 ¶¶ 19, 20, 33, 58, claim 8, Fig. 4; Ex. 1003 ¶¶ 102–107). These contentions, which Patent Owner does not oppose at this stage, are supported sufficiently by record evidence.

Regarding element 10(c), Petitioner contends that LeFebvre teaches the temperature of the wheel bearing should be monitored to determine if it is outside an acceptable range so it does not overheat by monitoring bearing temperature changes relative to other bearings and an alarm threshold that is provided. Pet. 30–31 (citing Ex. 1005 ¶¶ 33 58; Ex. 1003 ¶ 108).

Patent Owner argues that comparing temperatures of bearings to other bearing temperatures is not “determining if said temperature of the desired part is outside an acceptable range of temperatures.” Prelim. Resp. 37. Yet, the ’673 patent describes alarm conditions based on comparisons of bearing temperatures to temperatures of bearings on the same axle, trends, ambient conditions, average temperatures of bearings of a wagon or fleet over a time period, and predetermined bearing temperatures to identify deviations from these nominal operating conditions. Ex. 1001, 13:7–15:46.

The ’673 patent does not describe acceptable temperature *ranges*, and the term “range” appears only in claim 10. *Id.* at 16:44–48. Accordingly, an acceptable range of temperatures might include other bearing temperatures over time or a threshold below which a bearing temperature is acceptable.

LeFebvre compares a bearing's temperature to temperatures of other bearings, trends, and *alarm levels* to determine if a bearing's temperature is outside an acceptable range defined by such alarm trends/levels and/or other bearing temperatures. *See* Ex. 1005 ¶ 58. LeFebvre uses sensors to indicate the temperature of a bearing so the bearing does not become overheated, i.e., exceed an acceptable temperature level or range of temperatures. *Id.* ¶ 33. A sudden increase in temperature may indicate fault/failure. *Id.* ¶ 35. These alarm trends, thresholds, and levels define acceptable ranges of temperatures at least to the same extent as the levels described in the '673 patent.

Regarding element 10(d), Petitioner asserts that LeFebvre generates an alarm message if a monitored parameter such as temperature is outside the expected range, and the magnitude of the deviation is sufficient to cause alarm. Pet. 31 (citing contentions for element 1(d); Ex. 1003 ¶¶ 109–110). This contention, which Patent Owner does not contest at this stage, is supported sufficiently by record evidence.

We conclude on the present record that Petitioner has established a reasonable likelihood that claim 10 would be unpatentable over LeFebvre.

Petitioner asserts that LeFebvre monitors ambient air temperature to determine the temperature of a desired part in element 10(b) for claim 11, and LeFebvre performs elements 10(a)–10(d) by a single unit attached to the railcar for claim 12. Pet. 31–33 (citing Ex. 1005 ¶¶ 21, 37, 54, 55, 58, 93; Ex. 1003 ¶¶ 111–119). These contentions, which Patent Owner does not oppose at this stage, are supported sufficiently by record evidence.

We conclude on the present record that Petitioner has established a reasonable likelihood that claims 11 and 12 would be unpatentable over LeFebvre.

5. *Independent Claim 14*

Regarding the preamble and element 14(a), Petitioner contends that LeFebvre uses a data control unit as a communication management unit to receive data wirelessly from instrumented pads 16 that periodically collect readings from sensors disposed on a railcar. Pet. 35–36 (citing Ex. 1005 ¶¶ 34, 35, 55; Ex. 1003 ¶¶ 123–127). These contentions, which Patent Owner has not opposed, are supported sufficiently by record evidence. Sensors on instrumented pads 16 measure loads and temperature, and a microprocessor gathers readings to perform preliminary analysis and send messages to data control unit 23 when a pad detects fault or impending failure or on a given schedule. Ex. 1005 ¶¶ 33–35, 39–41.

Regarding element 14(b), Petitioner contends that LeFebvre uses inference engine techniques/heuristics to analyze collected data to determine the existence of actual failure conditions of wheel damage or derailment and potential or imminent failures based on statistical analysis of collected data to identify long term trends in wheel bearing temperature and avoid potential bearing burn off and possible derailment. Frequency spectrum analysis can infer specific bearing defects and identify a failing bearing in its early stages. Pet. 36–37 (citing Ex. 1005 ¶¶ 36, 56, 95, 58–66; Ex. 1003 ¶¶ 128–130).

Patent Owner argues that LeFebvre does not analyze received sensor data using heuristics to determine if an actual failure exists or to predict a potential or imminent failure based on statistical analysis of received sensor data. Prelim. Resp. 38–39. Patent Owner argues that Petitioner relies on the same disclosure for heuristic and statistical analysis without explaining how those portions disclose actual failure or predict potential failures, and LeFebvre is silent regarding any statistical analysis. *Id.* at 39–41.

The '673 patent indicates a CMU analyzes sensor data to detect imminent or actual failures. Ex. 1001, 2:63–66. A bearing temperature above a critical value requires a train to be stopped and a bearing removed. *Id.* at 14:1–3. In addition, “heuristics may be applied to determine potential failures based on statistical models and empirical data.” *Id.* at 2:66–3:3. A bearing temperature that exceeds a threshold value a certain percentage of times or is a certain standard deviation from a wagon or fleet average over time generates an alert to schedule maintenance. *Id.* at 2:3–6, 14:10–15:46, 12:61–65. Such *trending events* signify potential problems. *Id.* at 12:61–65.

As discussed for claim 1, LeFebvre uses inference engine to identify hunting, swaying, and rocking cars and trucks, flat wheels, shelled treads, bearing defects, derailed wheels, and displaced adapters by alarm thresholds, “long term trends,” and “[s]pecific bearing defects can be inferred from frequency spectrum analysis.” Ex. 1005 ¶¶ 54–57, 59–62, 64, 95.

LeFebvre also predicts potential or imminent failures from long term trends in bearing temperatures and frequency spectrum analysis. Ex. 1005 ¶¶ 58, 59. “Identifying a failing bearing in its early stages is important to preventative maintenance programs.” *Id.* ¶ 59. LeFebvre’s inference engine identifies periodicities, cross correlations and trends in time series data so behavior detectable at pad level will be seen by data control unit. *Id.* ¶ 54. Temperatures above thresholds or long term trends indicate potential bearing burnoff. *Id.* ¶ 58. Petitioner’s declarant, Mr. Ricca, testifies that LeFebvre’s data control unit uses heuristic inference engine techniques to identify actual failures of wheel damage and derailment and potential or imminent failures of bearing burn off and early stage bearing failure by statistical analysis, frequency spectrum analysis, and long term trends. Ex. 1003 ¶¶ 128–130.

Arguments of Patent Owner and its declarant, Dr. Shamos, regarding Petitioner's alleged failure to demonstrate heuristics used to determine actual failure conditions and potential failures based on statistical models do not address Petitioner's reliance on LeFebvre's teachings discussed above and for elements 1(a)–1(c) above. *See* Prelim. Resp. 38–41; Ex. 2001 ¶¶ 65–73.

LeFebvre uses heuristics (algorithms) in inference engine techniques to process load data and forces to generate frequencies and vibrations that are analyzed to identify actual railcar problems such as hunting, swaying, and warp of a truck or railcar, wheel defects (flat spots, shelled treads, or derailment), bearing defects, and bearing adapter displacement. Ex. 1005 ¶¶ 53, 54, 56, 59–62, 64; *see* Pet. 37.

LeFebvre uses such heuristically-derived frequencies with frequency spectrum analysis to identify a potentially failing bearing in its early stages so preventative maintenance can be scheduled for such bearings or prevent a potential full derailment resulting from a derailed wheel set or to identify wheels that may fail and need to be changed to prevent damage to cars and trucks. Ex. 1005 ¶¶ 59–62. Comparing bearing temperatures over time can identify long term trends in bearing conditions and the potential for bearing burn off. Derailment can be avoided by identifying periodicities and cross correlations in and between time series of bearing temperatures for a truck or car and deviations of bearing temperatures relative to other bearings of a car. *Id.* ¶¶ 54, 58; *cf.* Ex. 1001, 14:4–15:46 (analyzing bearing temperature trends over time and as percentages to identify potentially failing bearings and by comparing correlated bearing temperatures across axles); Pet. 37; Ex. 1003 ¶ 130 (testifying that frequency spectrum analysis and heuristic analysis of long term trends in bearing temperature are based on statistical analysis).

Regarding element 14(c), Petitioner contends that LeFebvre's data control unit transmits data and alarm messages to a remote location away from the railcar as was asserted for claim 6. Pet. 38 (citing Ex. 1003 ¶ 131).

Patent Owner asserts that the Petitioner states that LeFebvre transmits data and alarm messages to a remote location but does not identify *results* of any analysis are reported to an off-railcar location. Prelim Resp. 42–43.

According to the '673 patent, the CMU communicates data and results of analysis to a remote receiver. Ex. 1001, 3:1–3. The CMU communicates alarms to a remote location. *Id.* at 11:40–43. A customer may be alerted to schedule maintenance for a bearing that exceeds thresholds and averages of fleet and wagon bearings. *Id.* at 14:14–65. No details are described for the “results” or alerts that are communicated. *See id.* at 3:1–3; 13:30–15:46.

LeFebvre's system looks for signs of trouble and sends only essential indicative information. Ex. 1005 ¶ 53. Data control unit 23 sends alarm messages to remote locations when it detects faults of sufficient magnitude. *Id.* ¶¶ 52–66. Reports are sent to a central data handling location, operator, owner, or locomotive when components are “behaving sufficiently poorly.” *Id.* at ¶ 95. When serious trouble is identified, alert messages are sent to a locomotive or remote data service. *Id.* ¶ 56. Alerts identify specific bearing defects for maintenance. *Id.* ¶ 59. Alerts identify bearing burn off, possible derailment, wheel defects, truck and axle hunting, binding side bearings, dry center bowls, and displaced roller bearing adapters so that *maintenance can be scheduled* to remedy the fault or a component (wheel) can be replaced to avoid more serious potential faults. *Id.* ¶¶ 58–66; *see* Pet. 26, 36–38.

We conclude on the present record that Petitioner has established a reasonable likelihood that claim 14 would be unpatentable over LeFebvre.

6. *Dependent Claims 15–18 and 20*

Petitioner asserts that LeFebvre discloses sensing units (instrumented pads) that determine alarm conditions based on collected data and transmit a notice of the alarm conditions to a data control unit for communication to an off-railcar location (claim 15), makes alarm condition determinations using data from two or more sensing units (claim 16), places instrumented pads in a low-power, standby state (claim 17), joins a mesh network of sensing units (claim 18), and saves data in memory to compare to data from sensing units to identify trends or deviations from normal readings of the data stored in memory (claim 20). Pet. 38–41 (citing assertion for claims 1 (element 1(d)), 2, 12, 14 (elements 14(a)–14(d)); Ex. 1005 ¶¶ 24, 58; Ex. 1003 ¶¶ 133–145). These contentions, which Patent Owner has not opposed, are supported sufficiently by record evidence.

Pads 16 analyze time series data measurements for periodicities, cross correlations and behaviors that, if sufficient to cause alarm, are reported wirelessly to a data control unit 23 that makes further assessments to identify actual or potential faults to report to a remote central data handling location. Ex. 1005 ¶¶ 38, 52–66, 95. Data control units 23 analyze sensor data from many pads 16 to make determinations for a whole truck, car, wheeled set, or their individual components. *Id.* ¶¶ 55–66, 95. Bearing conditions are identified by comparing temperatures against other bearings and thresholds. *Id.* ¶ 58. To conserve power, pads 16 are placed in a passive, low power state and switch on periodically to gather readings from each sensor for preliminary analysis or when a fault or an impending failure indication is detected. *Id.* ¶¶ 34, 35. Instrumented pads 16 form a mesh network to communicate data. *Id.* ¶ 39, Fig. 5.

LeFebvre's data control unit 23 receives sensor data from multiple pads 16 and analyzes that data using its microprocessor and the algorithms of the inference engine to compare sensor data from all trucks on a rail car, draw inferences, and identify actual or potential faults using long-term trends and alarm levels to identify deviations from expected loads, vibration frequencies, load frequencies, and changing loads of sufficient magnitude to send an alert. *Id.* ¶¶ 24, 36, 53–66, 95. Petitioner asserts that skilled artisans would understand that data control unit 23 stores data received from pads 16 in some form of memory until data can be processed by the microprocessor on data control unit 23. Pet. 39–40 (citing Ex. 1003 ¶ 144).

We conclude on the present record that Petitioner has established a reasonable likelihood that claims 15–18 and 20 would be unpatentable over LeFebvre.

7. Independent Claim 21 and Claim 22

Petitioner contends that LeFebvre discloses a method for monitoring the operation of a railcar by collecting data at periodic intervals for railcar parameters using sensor units on a railcar, communicating the collected data to a communication management unit, and analyzing the collected data by applying heuristics thereto to determine if an actual failure exists and predict potential or imminent failures based on a statistical analysis of the collected data for the same reasons Petitioner asserted for the preamble of claim 1 and elements 14(1) and 14(b). Pet. 41 (citing Ex. 1003 ¶¶ 149–152).

Patent Owner argues that the LeFebvre does not determine if an actual failure exists and predict potential or imminent failures based on statistical analysis of the collected data, and the Petition does not address differences between these two clauses. Prelim. Resp. 43–44 (citing Ex. 2001 ¶¶ 78–79).

As discussed above for claim 14, LeFebvre analyzes data collected by data control unit 23 from pads 16 by using heuristics of an inference engine and algorithms to determine if actual failure exists (e.g., hunting, swaying, and rocking of a car or truck, wheel irregularities, bearing defects, derailed wheel set, displaced roller bearing adapters) based on heuristically-analyzed sensor data exceeding alarm thresholds for temperature, vibration frequency, high amplitude loads, pad leg loads, rapidly changing loads, repetitive force patterns at rotation frequencies, and forces at a pad. Ex. 1005 ¶¶ 53–66, 95.

LeFebvre uses an inference engine in data control unit 23 to apply heuristic analysis using algorithms to predict potential or imminent failures based on statistical analysis of collected data to identify potential bearing burn off and possible derailment when bearing temperatures deviate from an alarm threshold level or long term trends indicate such potential. Ex. 1005 ¶ 58. Specific bearing defects can be identified using frequency spectrum analysis to include a potential failing bearing so preventative maintenance can remedy it. *Id.* ¶ 59. Potential wheel failures may be identified so that wheels can be changed before being identified as a wheel failure requiring unscheduled maintenance. *Id.* ¶ 60. A derailed wheel set can be identified to prevent a possible full derailment and possible catastrophic consequences. *Id.* ¶ 61. Identifying deviations in angles of attack and hunting can be used to identify high rotational friction and dry center bowls issues in bearings for remediation to prevent potential damage to freight car trucks, tracks, and lading. *Id.* ¶ 61. LeFebvre uses statistical analysis as frequency spectrum and trend analysis to identify how much a condition deviates from nominal expected conditions to indicate an actual or a potential fault. *Id.* ¶¶ 35, 36, 53–66, 86, 95; *see* Ex. 1003 ¶¶ 128–130.

Regarding claim 22, Petitioner contends that LeFebvre assesses the collected data to determine if an alarm condition exists and communicates an alarm condition wirelessly to an off railcar location for the reasons asserted for claim 16 for similar limitations. Pet. 41 (citing Ex. 1003 ¶¶ 154, 155). These contentions, which Patent Owner has not opposed, are supported sufficiently by record evidence.

We conclude on the present record that Petitioner has established a reasonable likelihood that claims 21 and 22 would be unpatentable over LeFebvre.

F. Ground 2: Alleged Obviousness Over LeFebvre and Barone

Petitioner asserts the unpatentability of claims 8 and 9 under § 103 over LeFebvre and Barone. Pet. 16, 42–49.

1. Barone (Ex. 1007)

Barone discloses a system that collects sensor data for railcar wheels and wheel bearings using a wireless mesh network, analyzes the data to determine if a wheel bearing failure condition is approaching, and transmits alerts to a locomotive or remote central monitoring station. Ex. 1007 ¶¶ 42, 45, 85–88, 158, 159, 161, 201–220, Figs. 1, 2. Barone monitors bearing temperature, bearing vibration, bearing acoustic signature, wheel impact load, and car hunting and reports critical situations to a central monitoring station for continuous monitoring and trending data analysis. *Id.* ¶ 45.

A remote receiver in the locomotive receives and processes data from sensor nodes on a railcar and displays reports to the locomotive operators, particularly of especially urgent situations. Ex. 1007 ¶¶ 87–89. Barone performs low frequency analysis, filtering, time domain analysis, and fast Fourier transform analysis to identify defects. *Id.* ¶¶ 158, 159, 161, 201.

2. Claims 8 and 9

Regarding claim 8, Petitioner asserts that LeFebvre's system receives data from railcars at a locomotive or remote receiver and applies heuristics to determine deviations from nominal conditions as does Barone. Petitioner asserts that a skilled artisan would have been motivated to apply heuristics to sensor data collected at a remote receiver, e.g., a locomotive or central data handling location, from multiple railcars to identify dangerous situations that cannot be observed on a single railcar and allow computationally intensive heuristics to be performed. Petitioner asserts that LeFebvre's system would distinguish deviations by severity level and determine alarm conditions by severity level to transmit to a display unit on a train as Barone's system does. Pet. 42–48 (citing contentions for elements 1(b) and 1(d), claim 6; Ex. 1005 ¶¶ 3, 38, 52, 61, 95, claim 23; Ex. 1007 ¶¶ 37–42, 45, 87–89, 269; Ex. 1010, 2:24–34; Ex. 1003 ¶¶ 157–178). These contentions, which Patent Owner has not opposed, are supported sufficiently by record evidence.

Regarding claim 9, Petitioner contends that LeFebvre renders obvious determining a recommended course of action by identifying conditions that need to be repaired so corrective actions can be taken, and Barone generates appropriate alarms or indications to prompt users to take remedial actions so that a skilled artisan would have modified LeFebvre's alarm messages to prompt a user to take remedial action as Barone discloses. Pet. 48–49 (citing contention for element 8(e); Ex. 1005 ¶¶ 59–61, 64; Ex. 1007 ¶¶ 36, 191; Ex. 1003 ¶¶ 180–183). These contentions, which Patent Owner has not opposed, are supported sufficiently by record evidence. On this record, we find that Petitioner has established a reasonable likelihood that claims 8 and 9 would be unpatentable over LeFebvre and Barone.

G. Ground 3: Alleged Obviousness Based on Armitage

Petitioner asserts the unpatentability of claims 1, 2, 4, 6–11, and 13 under § 103 over Armitage, because Armitage does not disclose all of the limitations in a single embodiment according to Petitioner. Pet. 6, 50–69.

1. Armitage (Ex. 1006)

Armitage’s mobile railway car monitoring system couples sensors to undercarriage portions of railway cars, preferably non-rotating portions such as bearing mounts and brackets to determine fault conditions such as bearing temperature, vibration, and tracking deviation. Ex. 1006 ¶¶ 4, 25, 27, 34. A control node 130 on each railcar receives sensor information wirelessly and determines fault conditions based on a running average of temperatures of all wheels on a railcar 110 over time (dynamic threshold). *Id.* ¶¶ 27–31, 41.

Armitage applies heuristics to sensor data to identify fault conditions. A single wheel anomaly of vibrations or shocks may indicate a wheel out of round or a flat-spot fault condition. Ex. 1006 ¶ 42. Two such outliers for an entire wheel assembly indicate a failure of the entire wheel assembly or axle damage. *Id.* Outliers for an entire side of a railcar indicate cornering failure or an off-track condition. *Id.* A truck failure occurs when all four sensors on the same truck deviate from the other four sensors on a railcar. *Id.*

Armitage ranks faults by severity and provides the status of faults to an off-railcar collection node 340. A “yellow” condition requires service; a “red” condition is a serious deviation from normal operations that requires immediate service. Ex. 1006 ¶¶ 37–39, 44. Data correlation units on each railcar analyze sensor data with trend modeling and predictive analytics to identify sensors that lie outside of norms. *Id.* ¶ 44.

2. Independent Claim 1

Regarding the preamble, Petitioner contends that Armitage discloses a mobile railway car monitoring system with sensor nodes that monitor the undercarriage of a railway car. Pet. 50–52 (citing Ex. 1006, code (57), ¶ 14, Fig. 1; Ex. 1003 ¶¶ 188–190). These contentions, which Patent Owner has not opposed, are supported sufficiently by record evidence.

Regarding element 1(a), Petitioner contends that Armitage’s system couples sensor nodes 121–124/320–327 to undercarriage elements 111–114/312–315 to sense and report information about undercarriage elements and transmit sensor information to a control node on each railcar over a wireless network. Pet. 52–55 (citing Ex. 1006 ¶¶ 4, 12, 14, 21, 27, 33, 34, 54, 59, Figs. 1, 3, 5; Ex. 1003 ¶¶ 191–197). These contentions, which Patent Owner has not opposed, are supported sufficiently by record evidence. Each sensor node includes a sensor portion and a transceiver to communicate with the control node on each railcar. Ex. 1006 ¶¶ 14, 33.

Regarding element 1(b), Petitioner contends that Armitage’s control node analyzes collected sensor data using heuristics to determine whether a fault condition exists and uses statistical methods to identify deviations from nominal operating conditions. Pet. 55–57 (citing Ex. 1006 ¶¶ 27, 41, 42, 44, Fig. 2; Ex. 1003 ¶¶ 198, 199).

Patent Owner argues that Armitage does not apply a heuristic to data to determine deviations from nominal operating conditions because control node 130 determines a fault using a dynamically-determined threshold that normalizes data from all sensors to establish low and high thresholds in real time that change the operational values rather than considering acceptable or expected operating conditions of a railcar as claimed. Prelim. Resp. 45–48.

Patent Owner asserts that the Armitage's control node 130 processes sensor data from multiple nodes to determine a fault condition that "merely involves thresholding based on trend analysis." Prelim. Resp. 45. Patent owner argues that

The threshold value used in the thresholding process is dynamically determined based on a pool of sensor data. . . . The dynamically determined threshold value can include a running average of the temperature measurements for a population of sensors (e.g., all wheels on the railway car), a failure threshold dynamically determined based on a time series of sensor data from all sensors of the population of sensors, an upper limit for a dynamically normalized range of operation for the population of sensors, or a lower limit for a dynamically normalized range of operation for the population of sensors.

Prelim. Resp. 45 (citing Ex. 1006 ¶¶ 29, 42, 43; Ex. 2001 ¶ 82).

Patent Owner further argues that "[t]he dynamic normalization of Armitage necessarily results in a change of the range of operational values for the undercarriage element in real time based on sensor data" and "is a distinct type of analysis from merely using a predetermined static threshold that is set in advance" whereas limitation 1(b) "requires the determination of how much an operational characteristic differs from expected operating conditions." Prelim. Resp. 46, 47.

As discussed for Ground 1, the '673 patent identifies deviations from nominal operating conditions by analyzing (1) trending recommendations and repeat offender identifications, (2) bearings that are a predetermined amount hotter than axle mates, (3) bearing temperatures above ambient temperature a certain amount, (4) bearing temperatures compared to wagon and fleet averages, and (5) trending conditions. Ex. 1001, 13:30–15:45. The expected operating conditions are based on trends and averages.

Alarm thresholds are determined dynamically to provide an alarm threshold for a bearing based on the temperature of its axle mate bearing rather than a predetermined static threshold. Ex. 1001, 13:37–39. Even if a bearing must exceed a temperature of another bearing on the same axle by a predetermined amount, the temperature of the monitored bearing needed to generate an “Axle Differential Alarm” varies dynamically according to the temperature of its axle mate bearing plus some predetermined static amount. *Id.* A bearing’s temperature also must exceed dynamically-derived ambient temperatures by a certain amount to generate an alarm. *Id.* at 13:49–51.

Other alerts are based on variable conditions. Peak Analysis measures the *percentage* of bearing temperatures that are greater than a predetermined value in a time period. Ex. 1001, 14:17–22. A bearing temperature greater than a predetermined value does not trigger an alert or flag a bearing. The bearing temperature must exceed a value for some percentage of time in an undefined time period. *Id.* at 14:5–22. Bearings whose temperatures exceed ambient temperatures by a predefined value for a certain percentage of times in a time period are flagged as well. *Id.* at 14:23–29.

A bearing also is flagged when its average temperature over a period of days is a “certain standard deviation” from average bearing temperatures of the rest of a wagon (wagon average) and the rest of a fleet (fleet average). *See* Ex. 1001, 14:31–48.

Nominal operating conditions are defined by dynamic conditions and trends such as other bearing temperatures, ambient temperatures, average temperatures of wagon or fleet bearings over a time period, percentages of bearing temperatures greater than a predetermined value or greater than a dynamic ambient value, wagon average, and fleet average trends over time.

Armitage similarly compares data from individual sensor nodes to data from clusters of sensors so a deviation of a single sensor's reading from that of the cluster indicates a fault. "The degree to which any specific sensor deviates from this population is indicative of the severity of the mechanical condition of the component." Ex. 1006 ¶¶ 27, 29, 38, 40–43.

Like running wagon and fleet averages of the '673 patent (Ex. 1001, 14:31–48), Armitage compares each sensor reading to running averages of temperatures or other conditions to identify a sensor node that deviates by a certain amount from other sensors that create a dynamic threshold (Ex. 1006 ¶¶ 29, 40–43, Fig. 4). Similar to axle differential and ambient alarms (Ex. 1001, 13:37–67, *id.* at 14:23–30), Armitage compares readings of a sensor to readings of other sensors and ambient (Ex. 1006 ¶¶ 29, 40–43) to identify deviations from nominal operating conditions (failures). Ex. 1006 ¶ 42 (determine failure modes based on outlier data of sensor nodes 320–327).

Regarding elements 1(c) and 1(d), Petitioner contends that Armitage generates an alarm message (or "event") only for significant deviations from nominal operating conditions and uses a railway car health scorecard that distinguishes between potential failures that warrant maintenance and actual failures that require immediate service so skilled artisans would understand that Armitage's system assigns severity levels to deviations from nominal operating conditions and generates alarms (e.g., "yellow" or "red" alarms) based on the assigned severity level. Pet. 57–58 (citing Ex. 1006 ¶¶ 43, 44; Ex. 1003 ¶¶ 200–202). These contentions, which Patent Owner has not opposed, are supported sufficiently by record evidence. On this record, we find that Petitioner has established a reasonable likelihood that claim 1 would be unpatentable over Armitage.

3. Dependent Claims 2, 4, 6–9, and 13

Petitioner asserts that Armitage discloses every limitation of claims 2, 4, 6–9, and 13. Pet. 58–65 (citing Ex. 1003 ¶¶ 204–226), 68–69 (citing Ex. 1003 ¶¶ 240–242). These contentions, which Patent Owner has not opposed, are supported sufficiently by record evidence. Armitage establishes wireless communications with sensing units 121–124 (claim 2), locates a processing unit 130 on railcars (claim 4), transmits alarms to remote locations (claim 6), transmits data from sensing units to a remote location (claim 7), receives and applies heuristics to data from railcars to determine alarm conditions and transmit alarms to a train display unit (claim 8), determines a recommended course of action (claim 9), and distributes event engine functions (claim 13). Ex. 1006 ¶¶ 25–28, 40–44, Figs. 1–4.

On this record, we find that Petitioner has established a reasonable likelihood that claims 2, 4, 6–9, and 13 would be unpatentable over Armitage.

4. Independent Claim 10 and Claim 11

Regarding claim 10, Petitioner contends that Armitage discloses a system with temperature sensors to measure wheel bearing temperature and preferably to attach to non-rotating elements such as bearing mounts and brackets as recited in the preamble and elements 1(a) and 1(b), and skilled artisans would understand that the temperature of a rotating mechanical component such as a wheel bearing is measured indirectly by attaching a sensor to a nearby, stationary component that is in thermal communication with the rotating component as is known in industry. Pet. 65–66 (citing contentions for elements 1 Preamble and 1(a); Ex. 1006 ¶¶ 27, 34, Ex. 1003 ¶¶ 227–232).

Patent Owner argues that Armitage’s Figure 3 embodiment does not discuss temperature sensing and Petitioner does not explain how mounting Armitage’s sensor node on a bracket is in “thermal communication” with another part or how the system would cross correlate the determination of this other unnamed part to the bearing temperature. Prelim. Resp. 48–49. Patent Owner asserts that Armitage teaches that contact and non-contact temperature sensors can be used to monitor a temperature of undercarriage elements and can do so directly without using a temperature of another part to obtain the temperature of the undercarriage element. *Id.* at 50–51.

The ’673 patent describes a temperature sensing mote 10 mounted to a bearing adapter 12 of railcar wheel bearing 39 of a railcar. Ex. 1001, 5:43–47, Fig. 3. Because the temperature sensor is not in direct contact with the bearing, the device is calibrated so the temperature reading is indicative of the bearing temperature. *Id.* at 5:57–62.

Armitage similarly uses sensor nodes 121–124, 320–327 to sense the temperature of bearings and “preferably” attaches such a sensor node “to a non-rotating portion, such as a bracket, bearing mount, or other non-rotating structure” of a wheel assembly. Ex. 1006 ¶¶ 27, 34.

Petitioner reasonably contends, based on this disclosure of Armitage, that Armitage mounts a temperature sensing node to a bearing mount or a bracket to determine a temperature of a bearing. Pet. 65–66. Petitioner also asserts that a skilled artisan would understand that the bearing temperature is measured indirectly by attaching such a temperature sensor to a stationary part near the bearing and in thermal communication with the bearing as is commonly done in industry. Pet. 66. Petitioner supports its contentions with testimony of Mr. Ricca.

Mr. Ricca testifies that skilled artisans would understand attaching a temperature sensor to a stationary bearing mount or bracket near a bearing allows indirect measurement of a bearing's temperature as is commonplace in industry for decades and known to skilled artisans, and a skilled artisan would have been motivated to use this arrangement (rather than attachment to a moving part such as a bearing) as a less expensive, easier arrangement than a direct attachment. Ex 1003 ¶¶ 229, 230. Mr. Ricca supports this opinion by citing Pre-Grant Publication US 2005/0194497 A1 to Matzan ("Matzan") (Ex. 1018) and its teachings that "[s]ignals representing the temperature of such bearings are generated by temperature sensors that are *installed in close proximity of the wheel bearings.*" Ex. 1003 ¶ 231 ("Matzan merely provides confirmation and support for my opinion that this practice is commonplace in industry and that its advantages would be familiar to any [skilled artisan]."). Matzan was published on September 8, 2005, from an application filed on January 7, 2005, claiming priority to a provisional application filed on March 8, 2004. Ex. 1018, codes (22), (43), (60). Armitage was filed May 11, 2011, claiming priority to a provisional application filed May 11, 2010. Ex. 1006, codes (22), (43), (60). The '673 patent was filed May 18, 2016, claiming priority to provisional applications filed in 2010 (continuation-in-part) and 2012 (continuation). Ex. 1001, codes (22), (60), (63). It is undisputed that Armitage determines fault conditions based on sensed bearing temperature. Ex. 1006 ¶ 27. Armitage prefers to attach such sensors to non-rotating parts like bearing mounts and brackets. *Id.* ¶ 34. Petitioner has provided sufficient evidence to support its contentions that Armitage teaches or suggests to skilled artisans to measure bearing temperatures by placing a sensor on a bearing mount or bracket.

Regarding element 10(c), Petitioner asserts that Armitage determines if a wheel bearing's temperature is outside an acceptable temperature range as indicated by a running average of temperatures of all wheels on a railcar and the deviation is significant enough to warrant an alarm. Pet. 66–67 (citing contentions for elements 1(c) and 1(d) of Ground 3; Ex. 1006 ¶ 29; Ex. 1003 ¶¶ 233–235).

Patent Owner argues that “an acceptable range of temperatures” is not dependent on temperatures of other components. Prelim. Resp. 51. Yet, as discussed for Ground 1, the '673 patent compares a bearing's temperature to a temperature threshold *and* to average temperatures of wheel bearings on wagons and fleets over a period as a changing running average. Ex. 1001, 13:8–15:46. These average are based on a range of fleet and wagon bearing temperatures used to determine an acceptable running average temperature range over time similar to changing temperatures of bearing axle mates.

On this record, we find that Petitioner has established a reasonable likelihood that claim 10 would be unpatentable over Armitage.

Regarding claim 11, Petitioner contends that Armitage uses sensors to monitor ambient air temperature and weather conditions because these levels can affect readings taken from other sensors such as temperature sensors. Pet. 67–68 (citing Ex. 1006 ¶¶ 25, 29; Ex. 1003 ¶¶ 236–239). This contention, which Patent Owner does not contest at this stage, is supported sufficiently by evidence of record.

On this record, we find that Petitioner has established a reasonable likelihood that claim 11 would be unpatentable over Armitage.

H. Ground 4: Alleged Obviousness Based on Armitage and LeFebvre

Petitioner asserts the unpatentability of claims 3, 5, 12–18, and 20–22 under § 103 over Armitage and LeFebvre. *See* Pet. 6, 69–77.

1. Independent Claim 14

For the preamble, Petitioner contends that Armitage’s control node is a communication management unit that performs steps of claim 14. Pet. 73 (citing contentions for Ground 3; Ex. 1003 ¶ 261). This contention, which Patent Owner does not contest, is supported sufficiently by record evidence.

Regarding element 14(a), Petitioner contends that Armitage’s control node communicates wirelessly with sensor units on a railcar and it would have been obvious to do so periodically by equipping Armitage’s sensor nodes with digital sensors that transmit data on a periodic basis because such sensors are commonplace and would have been obvious to a skilled artisan to equip Armitage’s sensor nodes with digital temperature sensors. Pet. 73 (citing Ex. 1003 ¶ 263). Mr. Ricca testifies that digital sensors are common in the industry and have been in widespread use for decades so it would have been obvious to equip Armitage’s sensor node with a digital temperature sensor. Ex. 1003 ¶ 263.

Petitioner also contends that LeFebvre teaches this feature as a power-saving scheme where an electronic device enters a sleep mode to save power and awakens periodically to collect data, perform computations, and transmit data over a network as well-known, standard industry practices that skilled artisans would have incorporated into Armitage’s sensor nodes to save power predictably as LeFebvre teaches. Pet. 73–74 (citing Ex. 1005 ¶¶ 34, 35; Ex. 1003 ¶ 264 (citing Ex. 1005 ¶¶ 34, 35)).

Patent Owner argues that there is no motivation to modify Armitage to include digital sensors. Prelim. Resp. 53. In particular, Patent Owner asserts that Armitage discloses analog sensors so it is unclear why a skilled artisan would incorporate digital sensors into Armitage, and Petitioner's expert report provides a verbatim copy of Petitioner's conclusory argument without any support or explanation of what other modifications would be necessary to include digital temperature sensors in Armitage. *Id.* at 53–54 (citing Ex. 2001 ¶¶ 103, 104).

Because inventions rely on known components, “it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine elements in the way the claimed new invention does.” *KSR*, 550 U.S. at 418. Asserting it would have been obvious to add digital sensors to Armitage because “[d]igital sensors are commonplace” is not much of a reason “to have quipped Armitage’s sensor nodes with, for example, digital temperature sensors.” Pet. 73; Ex. ¶ 263.

Alternatively, Petitioner proposes to modify Armitage to use digital sensors based on LeFebvre’s teaching of the benefits of doing so. Petitioner proposes to improve Armitage for predictable benefits of saving power by awakening sensors from sleep modes periodically to collect data, perform computations, and transmit fault indications to a central control unit as LeFebvre teaches. Pet. 73–74 (citing Ex. 1005 ¶¶ 34, 35; Ex. 1003 ¶ 264); *see KSR*, 550 U.S. at 417 (“[I]f a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.”); Ex. 1001, 5:36–42 (sensor may remain in a standby state to conserve battery life).

That the '673 patent includes an embodiment that collects temperature data every minute a railcar is moving for a period of days before an analysis (Ex. 1001, 14:11–14) does not distinguish power-saving from periodic data collection as Patent Owner asserts (Prelim. Resp. 54), particularly where the '673 patent also indicates that a sensor (mote 10) may include a feature to conserve battery life by keeping mote 10 in a standby state and waking it periodically to delivery sensor readings (Ex. 1001, 5:36–42).

Even so, the law does not require that references be combined for the reasons contemplated by an inventor. *In re Beattie*, 974 F.2d 1309, 1312 (Fed. Cir. 1992); *see also Alcon Research, Ltd. v. Apotex Inc.*, 687 F.3d 1362, 1368 (Fed. Cir. 2012) (“We have repeatedly held that the motivation to modify a prior art reference to arrive at the claimed invention need not be the same motivation that the patentee had.”); *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1368 (Fed. Cir. 2006) (an implicit motivation to combine exists when an improvement makes a product stronger, cheaper, cleaner, faster, lighter, smaller, more durable, or more efficient).

LeFebvre would improve Armitage’s continuous monitoring process by maintaining sensors in a low powered state most of the time and taking samples on a given schedule to conserve power because “[m]ore frequent sampling will gain no further intelligence but increase power consumption.” Ex. 1005 ¶¶ 34, 35. Thus, Armitage would monitor railway components continuously at specified rates appropriate for the readings without a loss of accuracy while conserving power. *Cf.*, Prelim. Resp. 55; Ex. 2001 ¶¶ 107, 108. Armitage’s sensors may use power systems such as a battery or solar cell that have limited power. Ex. 1006 ¶¶ 14, 33.

LeFebvre expressly teaches that a periodic sampling rate can be set “at a frequency several times the highest frequency to be detected from the data” so that more frequent periodic sampling provides no more intelligence and merely increases power consumption. Ex. 1005 ¶ 34; *see KSR*, 550 U.S. at 421 (explaining that a person of ordinary skill in the art is a person of ordinary creativity not an automaton); *In re Ethicon, Inc.*, 844 F.3d 1344, 1351 (Fed. Cir. 2017) (skilled artisan has a desire to optimize variables of processes and products in known devices).

Regarding element 14(b), Petitioner contends that Armitage discloses statistical methods that can process sensor data and detect a deviation from nominal operating conditions to include distinguishing between potential failures that indicate a need for upcoming maintenance and actual failures that require immediate service. Pet. 74 (citing contentions for Ground 3, elements 1(b)–1(d), 8(e), and 9(a); Ex. 1003 ¶¶ 265, 266). For elements 1(c) and 1(d) in Ground 3, Petitioner contends that Armitage generates alarms for *significant* deviations from nominal operating conditions, not all deviations, and a “railway car health scorecard” distinguishes potential failures that require maintenance from actual failures that require immediate service:

Each event could be ranked by severity and status could be provided periodically, such as twice daily, to provide railcar location and system status. The event ranking could include a “yellow” condition which indicates that a railway car requires service, and a “red” condition which indicates that a sensor has detected a serious deviation from normal operations that requires immediate service.

Pet. 57–58 (quoting Ex. 1006 ¶ 44 and asserting that data correlation unit generates an alarm only for *significant deviations* from normal conditions).

Patent Owner argues that Petitioner does not explain adequately how Armitage heuristically determines that an actual failure exists or predicts potential or imminent failures as recited in element 14(b). Prelim. Resp. 56–58. Yet, Petitioner’s contentions for element 1(b) of Ground 3 assert that Armitage uses heuristics to determine whether a fault condition is present and processes sensor data to identify deviations from nominal operating conditions as “a standard deviation metric is employed to determine when data from one or more sensor nodes becomes an outlier from a main cluster of sensor node data, such as when data from a sensor node deviates by more than three standard deviations.” Pet. 56–57 (citing Ex. 1006 ¶¶ 27, 41).

Generating alarms for “significant” deviations from normal operating conditions (outliers) and further ranking these faults by degree of severity as those requiring service (“yellow” condition) and those requiring immediate service (“red” condition) addresses element 14(b)’s determination of actual versus potential failures based on statistical analysis of sensor data. Pet. 58.

The ’673 patent does not describe actual and potential faults per se. Those terms appear only in claim 14. The ’673 patent specification lacks any clear guidance for these terms to distinguish when a fault is an actual fault or potential fault. An Axle Differential Alarm could be an actual fault that “the bearing has been damaged” or a potential fault that “the bearing is ‘walking off’ the axle” or “grease is being purged.” Ex. 1001, 13:37–43; *see also id.* at 13:49–55. It is unclear from the ’673 patent specification when a conditions is an actual fault or a potential fault. An Above Ambient Alarm requires the bearing to be changed if the message does not clear but an Axle Differential Alarm does not. *Id.* at 13:37–64. Four of five criteria must be flagged to send other types of alerts. *Id.* at 14:10–15:46.

Regarding element 14(c), Petitioner contends that Armitage communicates results of the data analysis to an off-railcar location as an alarm condition as asserted for claim 6. Pet. 74 (citing contentions for Ground 3, claim 6; Ex. 1003 ¶¶ 267, 268).

Patent Owner argues that Petitioner fails to explain why contentions for claim 6 for “transmitting said alarm condition” would apply to element 14(c) for “communicating the results of said analysis to an off-railcar location.” Prelim. Resp. 58–59. Patent Owner asserts that Petitioner fails to identify any step that Armitage takes to transmit *results* of any analysis as recited in element 14(c) much less the heuristic and statistical analysis in element 14(b) because Petitioner appears to equate transmission of messages to the communication of results of the recited analysis. *Id.* at 59–60.

Petitioner reasonably considers Armitage’s analysis of sensor data at control node 130 to determine or detect a fault condition and then report the fault condition wirelessly to a collection system 150 that is remote from the railcar to describe transmitting an alarm condition to a location remote from the railcar in claim 6 of Ground 3 and “communicating the results of said analysis to an off-railcar location” in element 14(c) of Ground 4. Pet. 74; *id.* at 60–61 (citing Ex. 1006 ¶¶ 19, 28, 39, Fig. 2 (step 205)). In this instance, the *results* of the control node’s analysis of sensor data is detection of a fault condition that is reported to collection node 150. Ex. 1006 ¶¶ 27, 28.

The ’673 patent uses a communication management unit (CMU) to collect data from sensors on a railcar, analyze that data using heuristics to identify actual, imminent, or potential failures and “communicate both the data and the results of any analysis to a receiver remote from the railcar.” Ex. 1001, 2:61–3:3.

The '673 patent provides no other description of “results” of analysis of sensor data or any other type of results. The term “results” appears only in claim 14 and the passage cited above in the '673 patent specification.

Elsewhere, the '673 patent describes CMU 32 communicating data and an alarm to a remote location. Ex. 1001, 8:3–6, 11:40–46. A bearing temperature alarm results in a train crew checking a journal of an alarming bearing for signs of “walking off,” purging grease, or damage. *Id.* at 13:40–43, 13:52–55. A critical bearing temperature alarm results in the train being stopped and the bearing being removed. *Id.* at 14:1–3.

Armitage’s control node 130 determines and reports fault conditions including bearing temperatures, vibration signatures, dragging equipment, wheel impact/sliding conditions, shifted loads, hot wheels, opening doors, temperature, truck tracking deviations, and tank levels. Ex. 1006 ¶¶ 27, 28. If the result of the control node’s analysis of sensor data is a determination that a fault condition exists, the control node communicates that *result*, i.e., a determination that a fault condition exists, to collection node 150. *Id.* Claim 14 does not recite any particular features of the “results of said analysis.”

As discussed, Armitage applies heuristics to received sensor data to determine deviations from nominal operating conditions in element 1(b). As an example, vibration data may be used to identify mechanical conditions such as a wheel out of round or flat spot condition when the data deviates by more than three standard deviations, and the extent of the deviation indicates the severity of the mechanical condition of the component, and severity *and status* can be provided periodically. Ex. 1006 ¶¶ 41–44 (“yellow” condition requires service; “red” condition means a serious deviation from nominal operating conditions is detected); *see* Pet. 55–58; *cf.* Ex. 2001 ¶ 115.

On this record, we find that Petitioner has established a reasonable likelihood that claim 14 would be unpatentable over Armitage.

2. Independent Claim 21

Petitioner asserts that Armitage discloses element 21's preamble for reasons asserted for element 1(a) in Ground 3, Armitage teaches or suggests elements 21(a) and 21(b) alone or in combination with LeFebvre for reasons asserted for element 14(a) in Ground 4, and Armitage discloses element 21(c) for reasons asserted for element 14(b) of Ground 4. Pet. 77 (citing Ex. 1003 ¶¶ 282–285).

Patent Owner argues that a skilled artisan would not be motivated to modify Armitage in view of LeFebvre because incorporating the power saving scheme of LeFebvre in Armitage would change the basic operating principles of Armitage. Prelim Resp. 60.

As discussed for claim 14 of Ground 4, LeFebvre maintains sensors in a low powered state and awakens sensors on a given schedule to conserve power because “[m]ore frequent sampling will gain no further intelligence but increase power consumption” beyond what is needed for a particular reading Ex. 1005 ¶¶ 34, 35. Combining this teaching with Armitage would allow Armitage to monitor railway components continuously at specified rates without a loss of accuracy while conserving power for power systems such as a battery or solar cell that have limited power. Ex. 1006 ¶¶ 14, 33.

LeFebvre samples sensors “at a frequency several times the highest frequency to be detected from the data” so more frequent sampling provides no more intelligence and merely increases power consumption. Ex. 1005 ¶ 34; *see KSR*, 550 U.S. at 421 (a skilled artisan is a person of ordinary creativity not an automaton); *Ethicon*, 844 F.3d at 1351.

3. *Dependent Claims 3, 5, 12, 13, 15–18, 20, and 22*

Petitioner contends that LeFebvre discloses wireless mesh networks that would improve Armitage by connecting its sensor devices and control nodes to communicate better (claims 3, 5, 18), LeFebvre performs steps of claim 10 with a single sensor mode to reduce radio traffic to manageable proportions by using sensors to identify trouble and send only essential data to the control node (claim 12), completes steps of claim 1 at sensor devices, a control node, and collection node (claim 13), uses sensing units to identify alarm conditions and transmit alarms to the control unit for communication to a collection system located off the train (claim 15), Armitage heuristically analyzes aggregated data from multiple sensors and communicates alarms to a collection system located off a train (claim 16, 22), LeFebvre periodically samples data from sensors that wake up from a standby state (claim 17), and Armitage’s control nodes contain memory devices and storage mediums that store data received from sensor units during previous time periods to identify outlier nodes using standard deviation metric or trends (claim 20). Pet. 70–72, 74–77. These contentions, which Patent Owner has not opposed, are supported sufficiently by record evidence. On this record, we find that Petitioner has established a reasonable likelihood that claims 3, 5, 12, 13, 15–18, 20, and 22 would be unpatentable over Armitage and LeFebvre.

I. *Requested Denial of Petition under 35 U.S.C. § 325(d)*

Patent Owner argues that “[i]nstitution should be denied because the art and issues raised by the Petition are cumulative and substantially similar to the art and issues already addressed by the Office during prosecution.” Prelim. Resp. 13.

For the reasons discussed below, we decline to exercise our discretion under section 325(d) to deny institution even though some of the prior art presented in the Petition was presented to the Office during examination.

Section 325(d) provides in pertinent part:

In determining whether to institute or order a proceeding under this chapter, chapter 30, or chapter 31, the Director may take into account whether, and reject the petition or request because, the same or substantially the same prior art or arguments previously were presented to the Office.

35 U.S.C. § 325(d).

We apply the following two-part framework under § 325(d):

(1) whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office; and (2) if either condition of first part of the framework is satisfied, whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims.

Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH, IPR2019-01469, Paper 6 at 8 (Feb. 13, 2020) (precedential).

To determine whether the Petition presents “the same or substantially the same” art or arguments previously presented to the Office, we consider the factors set forth in *Becton, Dickinson*.⁶ *Id.* at 7 n.8. *Becton, Dickinson* provides a non-exclusive set of factors to use in applying the framework of 35 U.S.C. § 325(d).

⁶ *Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 (Dec. 15, 2017) (precedential as to § III.C.5, first paragraph) (“*Becton, Dickinson*”).

Under *Becton, Dickinson*, we consider:

(a) the similarities and material differences between the asserted art and the prior art involved during examination; (b) the cumulative nature of the asserted art and the prior art evaluated during examination; (c) the extent to which the asserted art was evaluated during examination, including whether the prior art was the basis for rejection; (d) the extent of the overlap between the arguments made during examination and the manner in which petitioner relies on the prior art; (e) whether petitioner has pointed out sufficiently how the examiner erred in its evaluation of the asserted prior art; and (f) the extent to which additional evidence and facts presented in the petition warrant reconsideration of the prior art or arguments.

See *Becton, Dickinson*, Paper 8 at 17–18.

In assessing the similarity of the prior art and arguments presented to the Office in examination and reexamination, we consider *Becton, Dickinson* factors (a), (b), and (d). If, after our review of factors (a), (b), and (d), we determine that the same or substantially the same prior art or arguments previously were presented to the Office, we consider factors (c), (e), and (f) to determine whether Petitioner has demonstrated material error by the Office. *Advanced Bionics*, IPR2019-01469, Paper 6 at 10.

1. Similarity of the Prior Art and Arguments

Patent Owner asserts that the Examiner considered both references by initialing the IDSs and stating “All References Considered Except Where Lined Through. /Y.A.X./” and by using both references as part of a search query to find relevant prior art. Prelim. Resp. 15–17. Patent Owner argues that denial of institution is warranted because the references were presented to the Office and considered by the Examiner as part of IDSs and search queries. *Id.* at 17.

The parties agree that Information Disclosure Statements (IDSs) filed during prosecution of the '673 patent cited LeFebvre and Armitage. Pet. 16; Prelim. Resp. 14–17. Under our controlling precedent, both references are considered to be “previously presented” to the Office. *Advanced Bionics*, IPR2019-01469, Paper 6 at 7–8 (“Previously presented art includes art made of record by the Examiner, and art provided to the Office by an applicant, such as on an [IDS], in the prosecution history of the challenged patent.”).

2. *Whether Petitioner Demonstrates Office Material Error*

Because the same prior art previously was presented to the Office, we consider *Becton Dickinson* factors (c), (e), and (f) to determine whether Petitioner has demonstrated material error by the Office.

Although LeFebvre and Armitage were presented to the Office, and the Examiner indicated on IDSs that both references were considered, neither reference was used in a rejection of any claims of the '673 patent application as both parties recognize. Pet. 15; *cf.* Prelim. Resp. 14–17.

LeFebvre and Armitage were cited with 54 U.S. patents, 22 published applications, 9 foreign patents, and 13 non-patent items. Ex. 1002, 139–150, 399–410. Several LeFebvre patents and a publication were cited. *Id.* at 143, 146, 403, 406; *cf. Boragen, Inc. v. Syngenta Participations AG*, IPR2020-00124, Paper 16, 22 PTAB May 5, 2020) (7 references were cited). The Examiner used many references and terms to search for prior art but not the features of LeFebvre and Armitage cited in the Petition. Ex. 1002, 123–137.

We do not consider the Examiner’s initials on an IDS citing almost 100 references with the Examiner’s failure to use LeFebvre or Armitage to reject claims of the '673 patent application as indicating that the Examiner sufficiently evaluated or appreciated the relevance of either reference.

The Examiner's Reasons for Allowance indicate that the Examiner did consider Searle or Baker as applying heuristics to data to determine deviations from nominal operating conditions, assigning a severity level to the deviations from nominal operating conditions, and determining an alarm condition based on assigned severity level. Ex. 1002, 493–494.

Petitioner contends, “the prior art relied upon herein teaches the very limitation found by the examiner to be missing from the prior art, which is highly persuasive evidence supporting a decision to institute trial.” Pet. 16.

The Petition demonstrates a reasonable likelihood that both references render unpatentable subject matter of independent claims 1, 10, 14, and 21 including limitations that Patent Owner argued were not taught or suggested by Searle and Baker to obtain allowance of those claims (i.e., claims 37, 47, 51, and 58). Pet. 18–24, 28–31, 50–58, 65–67; Ex. 1002, 424–433 (arguing that Searle and Baker do not teach or suggest applying a heuristic to received data to assign severity levels in independent claim 37, sensing temperature of a railcar part other than a desired part in claim 47, heuristically analyzing received data to determine actual failure or potential failures with statistical analysis in claims 51 and 58).

As indicated by our analysis of Grounds 1 and 3 above, Petitioner has shown a reasonable likelihood that LeFebvre and Armitage disclose subject matter the Examiner found lacking in Searle and Baker for claims 37–45 and 47–59 of the '673 patent application and these claims correspond to claims 1–22 of the '673 patent. The Petition relies on LeFebvre alone to disclose all limitations of independent claims 1, 10, 14, and 21, and Armitage alone to disclose all limitations of claims 1 and 10. Pet. 18–24, 28–31, 35–38, 41, 50–58, 65–67.

Petitioner’s showing of a reasonable likelihood of unpatentability of the ’673 patent claims based on LeFebvre and Armitage, whose disclosures cited in the Petition differ substantially from disclosures of Searle and Baker relied on by the Examiner and were not applied in any rejection during examination, satisfies the second prong of *Advanced Bionics* and weighs against exercising our discretion to deny institution.

J. Alleged Impermissible Cross-Referencing

Patent Owner argues, “the testimony offered by Petitioner’s expert is nothing more than a verbatim recitation of the arguments and evidence cited in the Petition” and “should therefore be afforded no weight.” Prelim. Resp. 28, 31. Yet, the Petition cites Mr. Ricca’s testimony as evidence to support contentions in the Petition. Any overlap or similarity would appear to result from the Petition citing Mr. Ricca’s Declaration without any deviation from the matters to which Mr. Ricca testifies. Mr. Ricca supports his testimony by citing record evidence as indicated by examples cited in the Preliminary Response. See Prelim. Resp. 28–30; see *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9 at 15 (PTAB Aug. 24, 2022) (precedential) (the critical inquiry is whether a declaration is conclusory and unsupported and whether it discloses underlying facts or data on which the opinion is based) (quoting 37 C.F.R. § 42.65(a) (“Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.”)). If declaration testimony is supported sufficiently and, in turn, supports contentions in the Petition, we do not give it little to no weight simply because it is repeated in the Petition. Thus, we credit Mr. Ricca’s declaration testimony for the matters asserted based on the authorities and technical reasoning provided therein.

III. CONCLUSION

For the reasons discussed above, we are persuaded that Petitioner has demonstrated a reasonable likelihood of prevailing in establishing that at least one of claims 1–18 and 20–22 of the '673 patent is unpatentable.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that *inter partes* review of the '673 patent is hereby instituted as to claims 1–18 and 20–22 on all grounds set forth in the Petition; and

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

IPR2023-00539
Patent 9,981,673 B2

PETITIONER:

Eric J. Rakestraw
Andrea L. Shoffstall
Daisy Manning
Husch Blackwell LLP
PTAB-ERakestraw@huschblackwell.com
PTAB-AShoffstall@huschblackwell.com
PTAB-DManning@huschblackwell.com

PATENT OWNER:

Jeff E. Schwartz
P. Marshall Ticer
Gary A. Hecht
Ryan North Miller
Fox Rothschild LLP
jeschwartz@foxrothschild.com
mticer@foxrothschild.com
ghecht@foxrothschild.com
rmiller@foxrothschild.com