

~~CONFIDENTIAL—CONTAINS PROTECTIVE ORDER MATERIAL~~

IN THE 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.

IPR2023-00538

PATENT NO. 9,365,223

ISSUED: JUNE 14, 2016

TITLE: SYSTEM AND METHOD FOR MONITORING
RAILCAR PERFORMANCE

EXHIBIT 2161

**DECLARATION OF MICHAEL I. SHAMOS, PH.D.
IN SUPPORT OF PATENT OWNER'S RESPONSE**

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1. I, Michael I. Shamos, declare as follows in connection with the proceedings identified above.

I. INTRODUCTION AND QUALIFICATIONS

2. I have been retained as an expert on behalf of Patent Owner to provide technical analysis and opinions relating to the Petition for *Inter Partes* Review (“Petition,” Paper 2) filed by Hum Industrial Technology, Inc. (“Hum” or “Petitioner”) challenging the validity of Claims 1–10, 13–18, and 20–32 (the “Challenged Claims”) of U.S. Patent No. 9,365,223 (“the ’223 Patent” or “the Patent”). I have also been asked to provide opinions on the Declaration of Mr. Steven Ricca (“Ricca Declaration,” Ex. 1003).

3. I am aware of contemporaneous litigation involving the parties in a case styled *Amsted Rail Company, Inc. v. Hum Industrial Technology, Inc. and Brett Wilson*, 4:22-cv-00445-AGF (E.D. Mo.) (the “Litigation”).

4. I previously submitted a declaration in this matter entitled, “Declaration of Michael I. Shamos, Ph.D. on Behalf of Patent Owner,” dated May 15, 2023 (“Shamos I”). My background, qualifications and compensation were set forth in ¶¶ 4-14 and 21-22 of Shamos I. The legal principles I was asked to follow were set forth in ¶¶ 25-33 of Shamos I.

5. In this Declaration, all emphasis has been added unless otherwise noted.

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6. The statements made and opinions provided in this Declaration are based on my own personal knowledge and, if called as a witness, I could and would testify in a manner consistent with the material in this Declaration.

II. MATERIALS CONSIDERED

7. I have been asked by counsel for Patent Owner to address Petitioner's assertions that the Challenged Claims would have been obvious. Petitioner does not allege that any Challenged Claim is anticipated.

8. In preparing this Declaration, I have considered all the material filed through the date of this Declaration in this proceeding and any other materials cited in this Declaration.

9. I have also relied on my education, skill, training, and experience in the relevant fields of technology. I have further considered the viewpoint of a person of ordinary skill in the art ("POSITA") at the time of the invention of the '223 Patent.

10. I reserve the right to supplement my opinions as expressed in this Declaration to address any new information obtained in the course of this proceeding, or based on any new positions taken by Petitioner.

III. SUMMARY OF MY OPINIONS

11. The following table summarizes the grounds of challenge ("Grounds") raised in the Petition:

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Grd.	Sec.	References	Challenged Claims
1	§ 103	LeFebvre	2–10, 18, 20, 21, 23, 25–32
2	§ 103	LeFebvre in view of Barone	13–17, 22, and 24
3	§ 103	LeFebvre in view of Denny and Provasnik	1, 24
4	§ 103	Armitage	2, 3, 5, 7, 13–18, 20–22, 26–28, 32
5	§ 103	Armitage in view of LeFebvre	4, 6, 8, 9, 10, 23, 25, 29–31
6	§ 103	LeFebvre, Denny, and Provasnik	1, 24

12. After a review of the '223 Patent and the alleged prior art asserted by Petitioner, it is my opinion that the Challenged Claims are not invalid under any of the Grounds. My opinions, and the bases therefor, are detailed throughout this Declaration.

IV. LEVEL OF ORDINARY SKILL IN THE ART

13. In my opinion, as explained in ¶¶ 42-46 of Shamos I, a POSITA would be a person with at least a B.S. degree in electrical engineering 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. Less work experience could be compensated for by a higher level of relevant education, and vice versa.

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V. CLAIM CONSTRUCTION

14. I understand that the Board found in the Institution Decision that no express claim construction is necessary in this proceeding. ID, 16. Patent Owner believed that the term “housing” require construction. Petitioner’s expert, Mr. Ricca, offered the opinion that the Board should adopt the plain and ordinary meaning of “housing” “because the claims are invalid under the plain and ordinary meaning of each recited term.” Ex. 1003, ¶ 48. I understand, however, that an interpretation that would render the claims invalid is not a valid justification for the Board to adopt plain and ordinary meaning.

15. Thus the plain and ordinary meaning of each term is to be applied. However, the parties appear to differ as to what the plain and ordinary meaning of “housing” is.

16. Petitioner does not appear to have applied the plain and ordinary meaning of “housing” as it would be understood by a POSITA, and, further, it takes positions in this proceeding that are inconsistent with positions it took in the Litigation.

17. The plain and ordinary meaning of “housing,” in the context of the Patent, is “enclosure.” The term “housing” is used consistently 18 times in the specification and 16 times in the claims, examples of which are presented below.

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18. That the housing must “enclose” (i.e., have an interior) is clear because the specification refers to various components as being mounted “within the housing.” See, e.g., “various components are installed within the housing 14,” (4:11); “A sensor 20 ... may be mounted within the housing 14” (4:23-24).

19. Further, the housing is described as having “openings”: “openings in the housing” (4:12-13); “an opening 24 in the housing 14” (4:28). If the housing were not an enclosure, it would not need openings.

20. The claims also make clear that a housing is an enclosure. See, e.g., claim 1: “said electrical circuitry positioned within said housing”, “said power source positioned within said housing,” “a probe external to said housing,” “said communication device positioned within said housing.” Likewise in claims 2 and 23. It is my opinion that these disclosures in the specification and the limitations recited in the claims would inform a POSITA that the claimed “housing” is an “enclosure.”

21. While Petitioner states that no construction is required for “housing,” its application of that term to the prior art is at odds with its plain meaning. Indeed, Petitioner appears to have implicitly adopted the construction it proposed in the Litigation, which is “one or more parts that covers, encloses, supports, or protects other components.” That construction is clearly wrong. The legs of a

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chair support the seat of the chair, but are not a “housing.” An umbrella protects a person from rain but is not a “housing.”

22. The Patent discloses two distinct embodiments: (1) one in which sensors are housed in a housing; or (2) one in which the sensors are built into the railcar. (“[i]n another alternate embodiment of the invention, one or more notes may be housed in alternative housings or built into the railcar itself. In one such embodiment, notes can be built into the form of an adapter pad similar to the type shown in U.S. Pat. Nos. 7,698,962 and 7,688,218.” (’223 Patent, 15:18-24.) U.S. Patent. 7,688,218 (Ex. 1015) is the issued patent corresponding to the LeFebvre reference, which is a patent application publication. That is, the Patent distinguishes between a “housing” and the built-in sensors of LeFebvre, which are “pads” offering no enclosure. Ex. 1001 at 15:18-24. The term “housing” does not appear in LeFebvre. This is consistent with the testimony of William LeFebvre. *See* Ex. 2008.

VI. PETITIONER HAS NOT SHOWN A REASONABLE LIKELIHOOD OF PREVAILING ON ANY GROUND

A. Ground 1: Petitioner has failed to show a reasonable likelihood that Claims 2–10, 18, 20, 21, 23, and 25–32 are obvious over LeFebvre

1. Claims 2-4 and 26-30

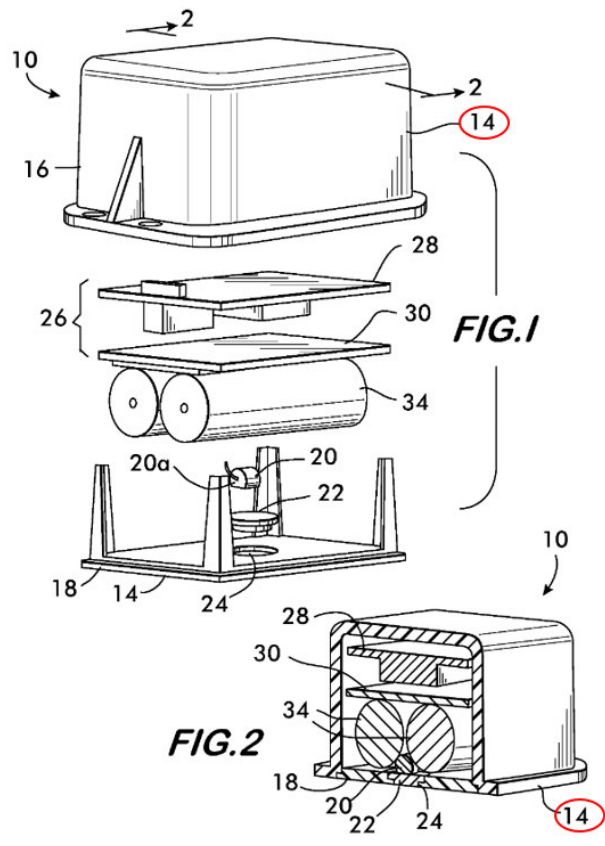
a. LeFebvre does not disclose a housing

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23. As discussed in connection with claim construction, above, LeFebvre does not disclose a “housing.”

24. LeFebvre does not teach or suggest “at least one temperature sensor device having: a housing,” as required by independent claim 2. It follows that LeFebvre also does not teach or suggest (1) “electrical circuitry,” (2) a “power source,” or (3) a “communication device” “positioned within said housing” as required by independent claim 2. A POSITA reading the ’223 Patent would understand that the term “housing” refers to an enclosure within which electronic components may be disposed. See Ex. 1001 at Figs. 1, 2, 3, 3A. FIGS. 1 and 2 (reproduced below), show that circuitry 26 (including main board 28 having communications circuitry) and power source 34 are clearly positioned within an enclosing housing 14.

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25. Housing 14 includes a lid section 16 and base 18 which together enclose sensors. The “pad” of LeFebvre, which must be mounted in a horizontal, load-bearing position, differs greatly from the mountable “housing” of the ’223 Patent, which allows the sensor to be mounted anywhere on a railcar and does not require specially-dimensioned bearing adapters.

26. The Petition seizes on the phrase “embedded into,” as used in LeFebvre:

FIG. 3 shows, in schematic form, an adapter pad 16 modified to carry out the objectives of the present invention. The pad contains

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a plurality of sensors 5 which are preferably embedded into its upper, side and lower surfaces or into other locations such as its end surfaces as may be necessary for the purposes of the invention as explained more fully below.

Ex. 1005, [0021]

27. Fig. 3 of Lefebvre is reproduced below.

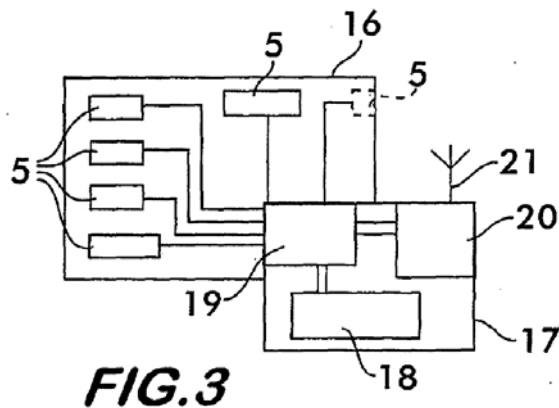
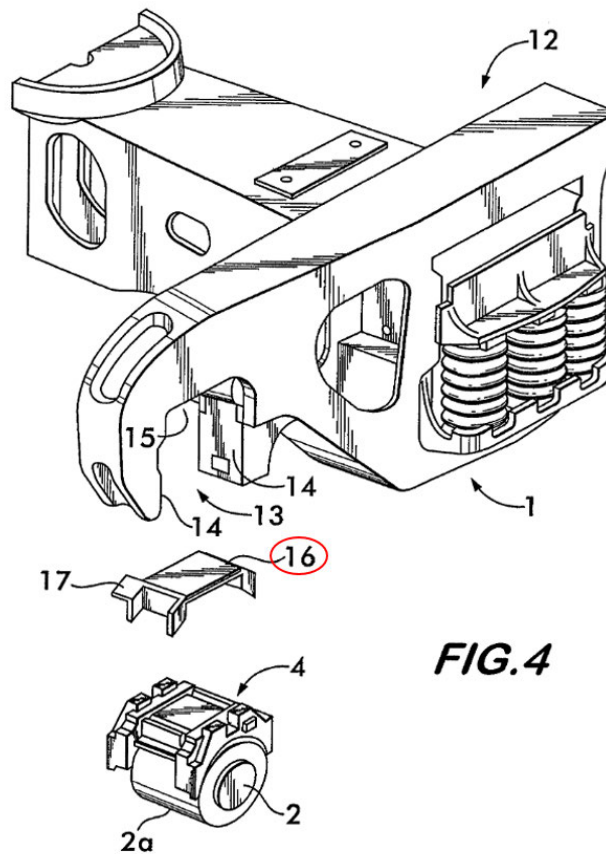


Fig. 3 simply shows sensors 5 embedded in a pad. There is no “housing.”

28. As shown in Fig. 4 of LeFebvre (reproduced below), a POSITA would recognize that instrumented pad 16 is not a “housing” as that term is used throughout the '223 Patent.

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29. LeFebvre does not ever suggest that its pad is a housing or an enclosure. Petitioner’s expert Mr. Ricca suggests that a “cast or injected molded elastomeric polymer” would be considered a “housing.” Ex. 1003, ¶ 81. However, coating something with a polymer does not constitute a “housing,” which implies that the components are both protected and removable. Mr. Ricca asserts, incorrectly, in ¶ 84, that LeFebvre “discloses a housing formed from a cast or injected molded elastomeric polymer.” LeFebvre discloses no such thing, but simply a pad (not a housing) “comprised of a cast or injected molded elastomeric polymer.” Ex. 1005, [0019]. LeFebvre explains that more details concerning the

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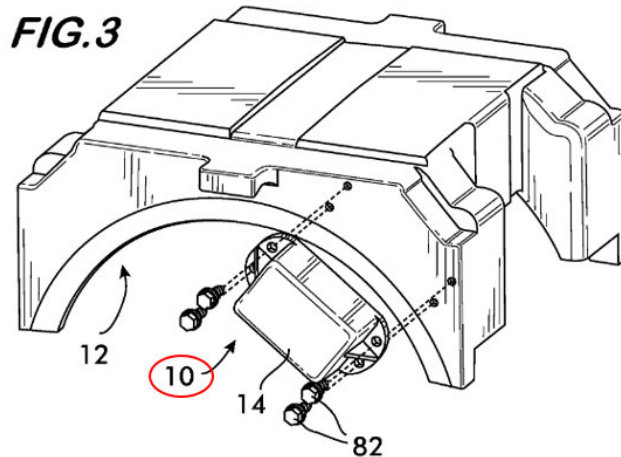
adapter pad 16 are described in U.S. Pat. Pub. 2005/0268813 to Van Auken, Ex.

2006. Ex. 1005 at ¶19. Van Auken (Ex. 2006), as with LeFebvre, never refers to any of its adapter pad embodiments as a “housing” or “enclosure.” It discloses three planar-shaped adapter pad embodiments 32, 232, and 332. Ex. 2003, Figs. 8-12. A POSITA would recognize that each of the Van Auken adapter pad embodiments, just like the LeFebvre adapter pad embodiment, are merely flat pads that are required to be installed in a load-bearing position in direct contact with a corresponding shaped planar surface of a “bearing adapter.” Ex. 2008 at ¶6. A POSITA, who is assumed to be familiar with LeFebvre and Van Auken, would see that each adapter pad necessarily requires the pad to be placed in a specific orientation on a correspondingly shaped “bearing adapter” to function properly. *Id.* at ¶6, 10. A POSITA would also know that the term “pad” is a term of art having a specific meaning for a load-bearing component of a railcar directly between a bearing adapter and the frame, i.e., in the exact position shown in LeFebvre Fig. 4.

30. The “pad” of LeFebvre, which must be mounted in a horizontal, load-bearing position, differs greatly from the mountable “housing” of the ’223 Patent which allows the sensor to be mounted anywhere on a railcar and does not require specially-dimensioned bearing adapters. In a preferred embodiment, sensor mote

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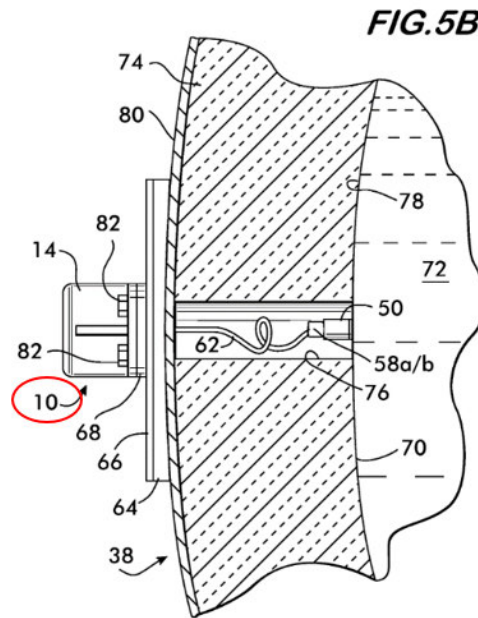
10 of the '223 Patent may be mounted vertically on a sidewall of a bearing adapter rather than in a horizontal load-bearing position. See Ex. 1001, fig. 3 (reproduced below).



In the figure, mote 10, being upside-down, is clearly not in a load-bearing position. This installation is not possible with the sensor pad disclosed in LeFebvre.

31. In another preferred embodiment, the housing of the '223 Patent (mote 10) may be mounted vertically on a sidewall of a liquid holding tank. See Ex. 1001, fig. 5B (reproduced below). This installation is also not possible with the sensor pad disclosed in LeFebvre.

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32. A POSITA familiar with the teachings of the '223 Patent that distinguish the invention over the prior pad embodiment of LeFebvre and Van Aucken, would understand that the “housing” recited in independent claim 2 is structurally distinct from the “pad” of the LeFebvre reference. Therefore, it is my opinion that a POSITA would not find that independent claim 2 obvious over the LeFebvre. It is also my opinion that a POSITA would not find claims 3, 4 and 26-30, which depend from independent claim 2, as obvious over LeFebvre.

b. LeFebvre does not disclose electrical circuitry “within” said housing

33. Because LeFebvre does not teach or suggest a “housing,” it also does not teach or suggest “electrical circuitry positioned within said housing,” as required by independent claim 2. When addressing this limitation, the Petition at

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23 alleges that “[t]he instrumented pad 16 comprises electrical circuitry, specifically: ‘a power source 18, an analog/signal conditioning means . . . and a communications unit 20’,” citing LeFebvre at [0021]. Petitioner’s reading of LeFebvre is incomplete and incorrect. What LeFebvre actually discloses at [0021] is that the extended portion 17 contains these components, not pad 16: “[t]he extended portion 17 contains a power source 18, an analog/signal conditioning means and analog to digital conversion means and an associated microprocessor unit 19 and a communications unit 20 which is preferably a low power radio transmitter/receiver having an antenna 21.” Pad 16 is not a “housing” at all, but is merely a “surface.”

34. Petitioner does not explain how or why the extended portion 17 and adapter 16, which do not constitute a housing at all, can form the single housing required by independent claim 2. Further, LeFebvre teaches away from combining components 16 and 17 to form a unitary single component: “[i]n preferred form, the pad 16 has an extended attachment portion 17 located so as to be relatively isolated from the forces transmitted through the adapter 16.” Ex. 1005 at [0021]. See also LeFebvre Fig. 3, which clearly delineates the boundaries of extended portion 17 and adapter pad 16, showing them to be different components.

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35. Because LeFebvre does not disclose a “housing,” it also does not teach or suggest a “power source positioned within said housing,” as required by independent claim 2. For the same reason, LeFebvre does not teach or suggest a “communication device positioned within said housing,” as required by independent claim 2. In addressing this element, the Petition again ignores the distinction between extended portion 17 and adapter pad 16. Petition at 23-25, relying on Fig. 3 of LeFebvre (see above). In Fig. 3, components 16 and 17 are separated by a boundary. Therefore, components 18 (power source) and 20 (communications unit) are not within the same housing, as required by independent claim 2. Furthermore, fig. 3 clearly shows the antenna 21 outside of the boundary of extended portion 17. Therefore, LeFebvre does not disclose a “communication device capable of broadcasting information . . . via wireless communication . . . positioned within said housing,” as required by independent claim 2.

36. Because a POSITA would understand that adapter pad 16 and extended portion 17 are separate components that do not collectively form a single housing. A POSITA would understand that the required “power source” and “communication device” are not “within said housing,” as required by claim 2. Each of claims 3, 4 and 26-30 depend from independent claim 2 and are therefore not obvious over LeFebvre.

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2. **Claims 5-10, 18, 20, 21, 31, and 32 - LeFebvre does not disclose heuristics or statistical analysis**

37. LeFebvre does not teach or suggest “a communication management unit [that] applies heuristics to analyze data collected from said one or more sensor units (a) to determine if an actual failure exists and (b) to predict potential or imminent failures based on a statistical analysis of said collected data.” A POSITA would understand that this limitation (“unit”) requires a single device, i.e., the communication management unit, to perform each of the two different types of analysis recited separately in the claim. The first analysis applies heuristics “to determine if an actual failure exists” and the second analysis applies heuristics for predictive purposes “based on a statistical analysis” of the data collected by the sensor. One aspect of this limitation is the determination of existing failures, i.e., “determine if an actual failure exists.” The other aspect of this limitation is the application of statistical analysis for predicting failures which have not yet occurred but may potentially develop in the future.

38. The '223 Patent explains that “[t]he CMU is capable of wirelessly collecting data from each of the motes and performing higher-level analysis of the data to detect imminent or actual failures. During such data analysis, heuristics may be applied to determine potential failures **based on statistical models and empirical data.**” ’223 Patent, 2:57-62.

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39. Petitioner does not address the fact that both “heuristics” and “statistical analysis” are recited separately on the claim and relies on the same disclosure in LeFebvre at [0058]-[0066] for both of these elements, which are distinct. See, e.g., Petition, at 28, stating “The data control unit then uses ‘inference engine techniques’ (i.e., heuristics) to analyze the collected data” then asserting that “[t]he ‘inference engine’ techniques used by the data control unit include, for example, statistical analysis of the collected data”. A “heuristic” does not necessarily require “statistical analysis” and “statistical analysis” does not necessarily involve “heuristics.” Petitioner merely relies on disclosures in LeFebvre of “inference” and an “inference engine.” Neither the term “heuristic” nor the term “statistical” appears in LeFebvre. Inference may be performed without either heuristics or statistical analysis, and LeFebvre certainly does not disclose that both are performed. For example, if a temperature sensor indicates that the temperature of an axle is at or above the axle’s melting point, one may infer that the axle will fail. No heuristic or statistical analysis is needed.

40. The claim requires both “heuristics” and “statistical analysis.” LeFebvre does not teach or suggest using “statistical analysis” to form predictions, and Petitioner fails to identify any such teaching or suggestion. Pet. at 28, 31.

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Likewise, Mr. Ricca also confuses “inference engine techniques” with “heuristics” in his ¶ 109. They are different, and one does not imply the other.

41. The Petition states: “LeFebvre discloses the use of heuristics, based upon data collected from one or more sensor units, to predict potential or imminent failures based upon a statistical analysis of the collected data,” relying on LeFebvre at [0058]-[0066]. However, LeFebvre merely refers to inferences, and never mentions any “heuristics” or statistical analysis.

42. Petitioner relies entirely upon the disclosure in LeFebvre at [0058] to show supposed “statistical analysis” of the collected sensor data as required by limitation 5(j). However, at most, LeFebvre merely teaches the use of collected data to infer that a condition exists, e.g., the inference engine discussed at [0036] of LeFebvre. A POSITA would recognize that LeFebvre merely describes certain types of conditions that are directly measured and certain types of inferences that may be made based on the directly measured conditions. LeFebvre introduces the scope and purpose of the disclosure in [0058-0066] by explaining that “Examples of performance that the system is capable of monitoring include ...” Next, LeFebvre explains that a “temperature sensor in instrumented pad 16 monitors relative changes in temperature against other bearings and provides an alarm threshold or long term trends to link to bearing condition. The well-being of a

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roller bearing can be inferred using either trends or alarm levels, avoiding a potential bearing burn off and possible derailment and providing a direct measurement that can be used to avoid false alarms from wayside hotbox detectors.” LeFebvre, [0058]. This is not a statistical analysis, and a POSITA would understand that this disclosure merely uses a direct measurement to draw an inference of a condition of the roller bearing, which is entirely different from performing “statistical analysis.” Similarly, using “long term trends” of a directly measured condition is not the same as performing “statistical analysis,” even if it could be considered a “heuristic.”

43. Although LeFebvre discloses a “Frequency Spectrum Analysis,” a POSITA would understand that this type of analysis does not refer to a statistical analysis. See LeFebvre, [0059]. Frequency domain analysis techniques merely transform time waveform data into discrete frequency components, e.g., by computing a fast Fourier transform (FFT). A purpose of such an analysis is to detect regular oscillations that may grow in magnitude. One may analyze a load sensor by transforming a time series of amplitude data into a spectral analysis of frequencies. This type of analysis is not statistical in nature. It is not based on any stochastic processes or statistical distribution and is therefore entirely different from performing a “statistical analysis.”

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44. LeFebvre is silent regarding how a “potential or imminent failure” may be predicted based on first acquiring a measured condition by a sensor as “collected data” and then performing a statistical analysis of the “collected data” to form a prediction. That is, LeFebvre simply does not perform any statistical analysis to form “predictions” and can solely measure actual conditions to form immediate inferences from those measurements. See Ex. 1005 ¶ 58-66.

45. Petitioner relies exclusively on LeFebvre’s power management disclosures when discussing limitations 5(g) and 8(b). Petition at 34. It is my opinion that a POSITA would not understand LeFebvre’s power management features to disclose “collecting data from said sensor at periodic intervals” as recited in limitations 5(g) and 8(b). It appears that, when the inventors of the ’223 patent wanted to claim power management, they did so explicitly as in claim 1 and limitation 1(g). Limitation 1(g) recites:

wherein the power consumption of said sensor device is managed by placing said sensor device in a standby state and periodically awakening said sensor device to collect readings from said temperature sensor and to transmit the information regarding the temperature sensed via said communication circuitry

Limitations 5(g) and 8(b), in contrast, recite “software performing the functions of collecting data from said sensor at periodic intervals.” The specification also expressly distinguishes between the two functions. For example, the power

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management feature, i.e., limitation 1(g), is explicitly described in the
specification:

Daughter board 30 includes power conditioning and
management circuitry and may include a feature to
conserve battery life which keeps mote 10 in a standby
state and periodically wakes mote 10 to deliver readings
from sensor 20.

Yet, algorithms (i.e., software as recited in limitations 5(g) and 8(b)) are separately
discussed:

The Level 2 algorithms use temperature data that had
been collected every minute while the railcar had been
moving during a period of days directly preceding this
analysis.

It is my opinion that a POSITA reviewing the specification and the claim language
would understand and recognize the distinction between these two functions and
would not look to implement “software performing the functions of collecting data
... at period intervals” with power management techniques. A POSITA would not
confuse the two functions the way Petitioner and its expert appear to have done.

46. LeFebvre discloses a sensor which “is programmed to switch on
briefly” but would normally be “in a low powered state most of the time.” See Ex.
1005 at ¶¶34-35. This is not “collecting data ... at periodic intervals” as recited in
limitations 5(g) and 8(b). Switching on the radio does not occur at “periodic
intervals,” but only instead only when a fault occurs.

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47. In finding a reasonable likelihood of unpatentability, the Board mistakenly found claim 5 to be broader than claim 1, writing “we understand claim 1 as a subset of ‘collecting data . . . at periodic intervals,’ and claim 5 reciting a broader limitation encompassing collection of data regardless of the power management technique used.” ID, 41-42. The systems recited in claims 1 and 5 are different from one another, and neither encompasses the other. , i.e., periodic data collecting and power management). In claim 1, the sensor is periodically awakened, transmits, and then goes to sleep again. This can achieve power management because power is saved when the sensor is asleep.

48. The system of claim 1 is different from that of claim 5, in which the sensor can operate continuously, yet only be polled at particular intervals. This does not relate to power management. Thus the limitation found in Claim 5 “collecting data from said sensor at periodic intervals,” is different from, not broader than, the limitation of claim 1. Therefore, while the same system could infringe both claims 1 and 5, a system that infringes claim 5 does not necessarily infringe claim 1, which requires broadcasting. Further, a system that infringes claim 1 need not necessarily infringe claim 5, which requires using heuristics and statistical analysis.

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49. Therefore, it is my opinion that a POSITA would not find independent claim 5 obvious over LeFebvre. Consequently, it is also my opinion that a POSITA would not find claims 6-10, 18, 20, 21, 31, and 32, which depend from independent claim 5, obvious over LeFebvre.

3. Claims 23 and 25 – LeFebvre does not disclose a housing mountable on a railcar

50. As discussed above in connection with claim 2, LeFebvre does not disclose a housing. *See* ¶¶59-72, *supra*. It is my opinion that a POSITA would not find that LeFebvre teaches or suggests “a housing mountable on a railcar,” as required by independent claim 23. Likewise, it is also my opinion that a POSITA would not find that LeFebvre discloses, teaches, or suggests (i) “electrical circuitry,” (ii) a “power source,” and (iii) a “communication device” that are “positioned within said housing,” as required by independent claim 23.

51. Therefore, it is my opinion that a POSITA would not find that independent claim 23 is obvious over LeFebvre. Consequently, it is also my opinion that a POSITA would not find claim 25, which depends from independent claim 23, obvious.

4. A POSITA would not have been motivated to modify LeFebvre - Instrumented pad 16 is not a housing

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52. Ground 1 is a single-reference obviousness ground. Neither Petitioner nor its expert provide any explanation for how or why a POSITA would modify LeFebvre to arrive at the invention claimed in the Challenged Claims. As explained extensively above, instrumented pad 16 is not a housing, LeFebvre does not refer to it as a housing, and a POSITA would understand it to be structurally different from a housing. Furthermore, a POSITA would understand that the instrumented pad 16 serves a different purpose and function from that of a housing, e.g., instrumented pad 16 is not an enclosure for protecting electrical components, as is the housing of the '223 Patent. Fig. 4 of LeFebvre shows pad 16 as a thin planar component and a POSITA would understand that a significant vertical load could bear down upon pad 16. See, e.g., Lefebvre [0017] stating that “[t]he axle bearings 2a and bearing adapters 4, best shown in fig. 4, are configured so that each bearing transmits the load which it carries and heat that it may generate through pads 16 and to the truck.” Petitioner simply provides no evidence to support any conclusion that a POSITA would find it obvious to modify LeFebvre to arrive at the invention claimed in claims 2–10, 18, 20, 21, 23, and 25–32.

53. Because there is nothing cited by Petitioner in the LeFebvre reference that suggests that it would be advantageous to position the pad 16 elsewhere on the railcar, or modify to enclose electrical components, it is my opinion that a POSITA

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would not be motivated to modify the flexible instrumented adapter pads to arrive at the invention claimed in the Challenged Claims.

B. Ground 2: Petitioner has failed to show a reasonable likelihood that Claims 13–17, 22, and 24 are obvious over LeFebvre in view of Barone

1. Claims 13-17 and 22

54. Claims 13-17 and 22 all depend, directly or indirectly, from claim 5.

As explained above, Petitioner has not shown that independent claim 5 would have been obvious over LeFebvre in connection with Ground 1. Barone does not cure any of the above-mentioned deficiencies of LeFebvre. The Petition does not rely on Barone as a basis for any limitation of independent claim 5 at all. Petition at 30-31. Specifically, Barone fails to teach or suggest “a communication management unit [that] applies heuristics to analyze data collected from said one or more sensor units (a) to determine if an actual failure exists and (b) to predict potential or imminent failures based on a statistical analysis of said collected data,” as required by independent claim 5.

55. Therefore, it is my opinion that a POSITA would not find that independent 5 is obvious over the combination of LeFebvre and Barone. It is therefore also my opinion that a POSITA would not find that each of claims 13-17 and 22, which depend from independent claim 5, are obvious.

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2. Claim 24

56. Claim 24 recites, “The monitoring device of claim 23 wherein at least a section of said temperature sensor is disposed **outside of** and **spaced from** said housing to be capable of contacting the surface of the railcar for which the temperature is to be monitored.”

57. Claim 24 depends from claim 23, which requires “a housing mountable on a railcar.” As shown in connection with Ground 1, LeFebvre does not disclose a housing, and Petitioner has failed to show that LeFebvre teaches or suggests “a housing mountable on a railcar.” The Petition does not rely on Barone for disclosing these limitations. See Petition at 50-51. Further Mr. Ricca does not address the “outside of” or “spaced from” limitations at all. Therefore, Petitioner has not shown that a POSITA would find claim 24 obvious over LeFebvre and Barone.

C. Ground 3: Petitioner has failed to show a reasonable likelihood that Claims 1 and 24 are obvious over LeFebvre in view of Denny and Provasnik

58. Claim 1 recites “a housing mountable on a railcar,” as does independent claim 23, from which claim 24 depends. As explained in Ground 1, LeFebvre does not disclose a housing. Petitioner has failed to show that LeFebvre teaches or suggests “a housing mountable on a railcar.” Likewise, Petitioner has

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failed to show that LeFebvre teaches or suggests (i) “electrical circuitry,” (ii) a “power source,” and (iii) a “communication device” that are “positioned within said housing” as required by independent claims 1 and 23. The Petition does not rely on Denny or Provasnik for disclosing these limitations. See Petition at 38, 53. Provasnik does not relate to trains, but instead to automotive engines. The failure modes of trains are entirely different from those of automobiles.

D. Ground 4: Petitioner has failed to show a reasonable likelihood that Claims 2, 3, and 26–28 are obvious over Armitage

1. Priority Date of the ’223 Patent

59. I have reviewed the declarations of Andrew Martin and Jay Monaco as well as the exhibits cited therein. I understand that Petitioner asserts that Armitage is prior art to the ’223 patent under 35 U.S.C. §102(a). I also understand Petitioner indicated it would rely on Armitage’s provisional filing date under §102(e), though I note that the Armitage provisional application has not been entered into evidence in this proceeding. Armitage was published on November 17, 2011. The Armitage non-provisional application was filed on May 11, 2011. Armitage claims priority to a provisional application filed on May 11, 2010. I understand that Armitage’s critical date under §102(e) may be one or the other of these earlier two dates depending on which claim of the ’223 Patent it is applied to, depending on whether Petitioner is able to prove Armitage is entitled to its

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provisional filing date for purposes of §102(e). I cannot provide an opinion as to the exact critical date Armitage is entitled to as the evidence required to render that opinion is not currently of record.

60. I understand that, for Armitage to be entitled to its provisional filing date under §102(e), the Petitioner must prove that 1) Armitage is entitled to claim the benefit of the provisional filing date under 35 U.S.C. § 119, including proof of proper written description support for the claims of the later patent or patent publication; and 2) that the material relied on for purposes of Petitioner's invalidity grounds is actually present in the provisional filing. I understand that if Petitioner fails to prove either requirement, then it cannot rely on the filing date of the provisional application for purposes of §102(e). Because the provisional application referenced in Armitage has not been made of record, Petitioner cannot prove either element above.

61. I understand that Armitage would not be prior art if the inventors of the '223 Patent either (a) reduced the claimed invention to practice prior to the applicable critical date of Armitage, or (b) conceived of the claimed invention prior to that critical date and exercised reasonable diligence between that critical date and a later actual or constructive reduction to practice.

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62. I understand that reduction to practice occurs when the inventor or those working on the inventor's behalf: (a) constructs an embodiment or performs a process that meets the claimed invention, and (b) demonstrates that the invention is suitable for its intended purpose. I further understand that reduction to practice does not require the invention, when tested, to be in a commercially satisfactory stage of development. However, it is my understanding that the inventors of the claimed invention must recognize that the results of the testing demonstrate that the invention is suitable for its intended purpose. Therefore, when testing is conducted by third parties, reduction to practice occurs when the inventors receive and comprehend the results and not when the tests were conducted.

63. I understand that the character of the invention and the problem it solves determine whether testing is required, and that the sufficiency of testing is determined using a commonsense approach. Actual reduction to practice does not require commercial perfection, or absolute replication of circumstances of the inventions' ultimate use.

64. The purpose of the railcar monitoring system described and claimed in the '223 is to provide a system and method for enabling rail operators to predict operational failures and provide adequate warning of those failures to allow for directed human intervention before catastrophic failures occur. Ex. 1001 at 3:8-13.

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65. It is my opinion that actual reduction to practice of the invention claimed in the '223 Patent required substantial testing. Specifically, the combination of hardware elements and algorithms designed to detect potential problems is sufficiently complex to require *in situ* testing.

66. I have reviewed Martin and Monaco declarations (Exhibits 2013 and 2014, respectively) and the evidence cited therein. I have attached as Appendices A and B to this declaration charts comparing the claims of the '223 Patent with the evidence of the prototype devices and systems Amsted conceived of prior to May 2010. Appendix A relates to evidence of conception; Appendix B relates to evidence of reduction to practice, both of which I incorporate here. It is my opinion that the systems that were in use in Australia during the trial with SCT Logistics met the limitations of the claims of the '223 Patent as shown in the claim charts. Furthermore, based on the evidence I have reviewed, including the Declaration of Andrew Martin and the evidence cited therein, I understand that Mr. Martin and Brent Wilson, and/or others at Amsted and elsewhere working under the direction of Mr. Martin and/or Mr. Wilson, exercised reasonably continuous diligence throughout the remainder of 2010 and into 2011. By August 2011, Mr. Martin and Mr. Wilson, along with inventor William LeFebvre, understood that their system worked for its intended purpose. Based on my review of these

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materials, I further understand that the methods claimed in the '223 Patent were a natural use for the structures disclosed in the March 2010 installations.

67. In the event that Armitage is deemed to be prior art to any of the Challenged Claims, I explain below why the Challenged Claims are patentable.

2. Armitage is not prior art to claims 2, 3, 26-28

68. As explained above beginning at ¶¶ 59-66, Armitage is not prior art to claims 2, 3, and 26-28 and therefore cannot properly be applied to those claims. Because a POSITA would recognize that claims 2, 3, and 26-28 have an earlier effective filing date than the earliest priority date to which Petitioner has established that Armitage is entitled, it is my opinion that a POSITA would not find that independent claim 2 and dependent claims 3 and 26-28 are obvious over Armitage.

3. Armitage does not teach or suggest claim 26

69. Limitations 26(b) and 26(c) are identical to limitations 5(j) and 5(k). As I show below beginning at ¶¶ 74-81, Armitage does not disclose, teach, or suggest limitations 5(j) and 5(k), and therefore does not disclose limitations 26(b) and 26(c). Petitioner's reference to claim 3 does not explain how the limitations of claim 26 are taught or disclosed by Armitage. Therefore, it is my opinion that a POSITA would not find that claim 26 is obvious in view of Armitage.

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E. Ground 5: Petitioner has failed to show a reasonable likelihood that Claims 4-10, 13-18, 20-23, 25, and 29-32 are obvious over Armitage in view of LeFebvre

1. Claims 4, 29, and 30

70. As explained above, Petitioner has not shown that independent claim 2 is obvious over either Lefebvre or Armitage separately. Combining these references does not cure the deficiencies of either of them. Each of claims 4, 29, and 30 depend from independent claim 2 and consequently Petitioner has not shown that they are obvious.

2. Claims 5-10, 13-18, 20-22, and 31-32

a. Armitage requires continuous monitoring of sensor data and there is no motivation to combine it with LeFebvre

71. Petitioner fails to explain how or why Armitage and LeFebvre would be combined to teach or suggest “software performing the functions of collecting data from said sensor at periodic intervals,” as required by independent claim 5. Specifically, the Petition contains no explanation for why a POSITA would implement the alleged “power-saving scheme” as disclosed in LeFebvre into the sensor device of Armitage in view of Armitage’s disclosure that its sensors are continuously sending data reports to a data control unit which “continuously analyzes the datastream from the sensors” and enable “continuous monitoring of all critical railway car components.” Armitage at [0044].

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72. There is no indication in Armitage that power-saving would even be a desired feature. Further, Armitage suggests the opposite, disclosing at [0044]: “Realtime, continuous monitoring of all critical railway car components can be monitored.” That is, the sensors do not go to sleep. If Armitage were modified to put a sensor asleep, it might miss important failure indications, rendering it inoperable for its intended purpose. This would therefore not motivate a POSITA to combine this feature from LeFebvre into Armitage. In any case, it is clear from the disclosures of Armitage and LeFebvre that a POSITA would not be motivated to combine them. For example, LeFebvre discloses that its power feature “is programmed to switch on briefly” but would normally be “in a low powered state most of the time.” LeFebvre at [0034]-[0035]. Mr. Ricca acknowledges that this would be the result of implementing LeFebvre’s power feature. Ex. 1003 at ¶349. A POSITA would not look to make this modification to Armitage because “continuous monitoring of all critical railway components” is a vital feature of Armitage’s monitoring system. Armitage at [0044]. A POSITA would read this disclosure of Armitage and recognize that sensors 121-124 operate in the conventional manner by continuously performing sensing while the railcar is in motion. For example, Armitage can only analyze sensor data by performing a comparative analysis of one sensor’s data to a pool of available sensor data to

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identify outliers. Armitage [0030], [0042]. Armitage explains, “[w]hen one or more of the sensor nodes begin to deviate from the others in the population, then a failure condition could be determined.” Armitage [0030]. Therefore, a POSITA would recognize that Armitage’s system is only capable of performing this comparative analysis while all of the sensors are on, i.e., “continuous monitoring” of data from a population of sensors to find outliers. Armitage [0030], [0042]. Forcing the sensor pad to be “in a low powered state most of the time” would frustrate Armitage’s continuous monitoring by disrupting the running average calculated from a population of sensors.

73. Further, a POSITA would not expect to successfully combine Armitage and LeFebvre because the dynamic continuous monitoring disclosed in Armitage is incompatible with the power-saving feature of LeFebvre. For example, Armitage utilizes “a dynamic threshold of failure” that is determined using data from a population of sensors. Armitage at [0041]-[0044]. This “dynamic normalization” requires constant and continuous data streams from the respective sensors to properly function. Armitage [0043] (stating that “sensor network on each railway car is employed to dynamically define norms of operation for each of the critical mechanical components.”). To accommodate LeFebvre’s low power feature, a POSITA would have to navigate the complexities of how to perform the

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dynamic normalization and comparative analysis of Armitage using sensors that are turned off most of the time. Petitioner fails to explain how that should be done and neither LeFebvre nor Armitage provides any disclosure that would do so. Thus, a POSITA would not be motivated to combine LeFebvre and Armitage together.

b. Armitage does not teach using statistical analysis techniques for predictive purposes

74. Armitage and LeFebvre fail to teach or suggest “wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor units (a) to determine if an actual failure exists and (b) to predict potential or imminent failures based on a statistical analysis of said collected data,” as required by independent claim 5. Petitioner does not apply LeFebvre against any of limitations 5(j) or 5(k). Petitioner relies only on Armitage. Petition, 75. Petitioner never shows that both heuristic and statistical techniques are taught in the combination.

75. The Petition alleges that Armitage’s control node 130 corresponds to the claimed “communication management unit” and applies heuristics by relying on the same analysis presented with respect to dependent claim 3. See Petition at 64-66 and 75. However, the Petition does not point to any disclosure of a

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“prediction.” The Petition simply alleges that the “control node collects this data and analyzes it to determine whether a fault condition is present.” Id., 64.

76. However, determining whether a fault condition is **currently** present is not the same thing as making a **future** prediction that is “based on a statistical analysis of said collected data.” The limitations in 5(j) and 5(k) require that heuristics be used in two different ways.

77. The first requirement is to “determine if an actual failure exists.” Limitation 5(j). The second requirement is “to predict potential or imminent failures based on a statistical analysis of said collected data.” Limitation 5(k). All that Petitioner has done is show that the combination discloses a system capable of detecting whether a fault condition event currently exists and whether maintenance is immediately required or may be put off until later. See Petition, 58.

78. Armitage [0044] merely discloses establishing a ranking for events based on their severity, e.g., “yellow” or “red” depending on how much a sensor reading deviates from normal. This is not a statistical analysis of the data collected from a specific sensor or even a pool of individual sensors. Rather, it is merely a comparative analysis using basic arithmetic, e.g., “if the sensor reading is between 15 and 25, signal condition yellow; if the sensor reads above 25, signal red.”

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79. Armitage may only determine a fault condition by scanning for outliers, e.g., by comparing single sensor data against a corresponding pool of sensor data from a plurality of sensors to find outliers. Armitage [0042]. Armitage only determines “failure alerts” of a presently detected fault condition by performing a comparative analysis of sensor information from one sensor node against the corresponding sensor information from a plurality of sensor nodes. For example, “When one or more of the sensor nodes begin to deviate from the others in the population, then a failure condition could be determined.” Armitage [0030]. This is not statistical analysis.

80. Armitage [0041] refers to FIG. 4, which merely contemplates performing a comparative analysis of sensor 325 against the other sensors 320, 322, 327, 326, etc. Armitage explains that “the population of all of sensor nodes 320-327 is taken into account to determine a dynamic threshold of failure.” Id. Next, Armitage explains that a failure condition may be determined by a standard deviation metric, e.g., “when data from a sensor node deviates by more than three standard deviations, among other examples.” Id. Both of these analysis techniques require a pool of sensor data and would not work with data from a single sensor. Armitage may determine “failure alerts” of a presently detected fault condition by

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performing a comparative analysis of sensor information from one sensor node against the corresponding sensor information from a plurality of sensor nodes.

81. A POSITA would understand that the process taught by Armitage is merely comparative in nature and can only establish a fault condition based on how much a single sensor deviates from the other sensors on the railcar. Furthermore, the system of Armitage requires a plurality of sensors to determine outliers. This is not the same thing as applying a heuristic, i.e., one or more rules, to “predict potential or imminent failures based on a statistical analysis of said collected data,” as required by independent claim 5. Armitage merely performs a comparative analysis that determines a current failure has occurred when a single sensor data is outside of a threshold level (in this case three standard deviations from the average). Furthermore, this type of analysis does not “predict potential or imminent failures,” as explained in more detail below.

c. Armitage does not teach using statistical analysis techniques for future predictions

82. When addressing limitation 5(k) Petitioner fails to point to any disclosure in Armitage of a “prediction.” Petition at 64-66, 75. Furthermore, nothing in Petitioner’s prior analysis addresses the claim requirement of “predict[ing] potential or imminent failures based on a statistical analysis of said collected data.” Indeed, the words “predict” are never used by Petitioner.

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Therefore, for this reason alone, Petitioner has failed to show that claim 5 is obvious over Armitage and LeFebvre.

83. The closest semblance of an argument related to “predictions” is made by Petitioner with reference to Armitage [0044]. See Petition, 66. Here, Petitioner alleges that “Armitage’s system . . . distinguishes between potential failures (which warrant maintenance) and actual failures (which require immediate service). Id. For example, when discussing “potential failures” Petitioner merely cites to Armitage [0044]. However, in this example Armitage merely assigns a status to the “event” indicating whether maintenance is currently required or may optionally be performed later. Armitage explains that “yellow” indicates maintenance may optionally be performed later and “red” indicates maintenance must be performed immediately. Armitage [0044].

84. Thus, it is my opinion that a POSITA would not find that independent claim 5 is obvious over Armitage and LeFebvre. It is also my opinion that a POSITA would not find that claims 6-10, 13-18, 20-22, and 31-32, which depend from independent claim 5, obvious.

3. Claims 23 and 25

85. Armitage is not prior art to independent claim 23 because claim 23 is entitled to the benefit of the earliest claimed priority date.

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86. Further, Armitage does not teach or suggest (i) “electrical circuitry,” (ii) a “power source,” and (iii) a “communication device” that are “positioned within said housing” as required by independent claim 23. As explained above, LeFebvre also does not teach or suggest “a housing,” nor does LeFebvre teach or suggest “a housing mountable on a railcar.” Accordingly, LeFebvre fails to cure the deficiencies of Armitage. Furthermore, this ground of the Petition only relies on LeFebvre for limitation 23(f). See Petition, 72.

87. Petitioner has failed to show that Claim 23 is obvious in view of Armitage and LeFebvre. Claim 25 depends from independent claim 23 and consequently Petitioner cannot show that claim 23 is obvious.

F. Ground 6: Petitioner has failed to show a reasonable likelihood that Claims 1 and 24 are obvious over Armitage in view of LeFebvre, Denny, and Provasnik

88. I have already explained why a POSITA would not be motivated to combine Armitage and LeFebvre in reference to claims 5 and 8. See ¶¶ 71-73, above. To address the requirements of this limitation 1(g), the Petition relies purely on earlier analysis performed with respect to limitation 8(b) found in sections X.A.7.b (Petition at 34) and X.E.3.b (Petition at 71). See Petition, 86. Each of these sections relies exclusively on LeFebvre. A POSITA would not be motivated to modify Armitage according to the teachings of LeFebvre to reach the subject

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matter of limitation 1(g) because Armitage’s dynamic continuous monitoring features, critical for Armitage’s system to function properly, would be frustrated by LeFebvre’s power management scheme which requires that “the sensor node to be in a low powered state most of the time” according to Petitioner’s own expert. *See* Ex. 1003 at ¶349.

89. Notably, limitations 8(b) and 1(g) have different scopes. In particular, limitation 8(b) requires “said software performing the functions of collecting data from said sensor at periodic intervals.” This is not the same requirement as placing “said sensor device in a standby state,” as required by limitation 1(g). As I explained above, given the differences between the two functions in the specification and claims, a POSITA would not be confused by them the way Petitioner appears to be. *See* ¶81, *supra*.

90. Armitage discloses that the “sensor nodes 121-124 will sense and monitor the equipment while railway car 110 is in motion, such as when rolling.” Ex. 1006 [0021]. A POSITA would understand that Armitage teaches that the sensors 121-124 operate in a conventional manner by continuously performing sensing while the railcar is in motion. Armitage explicitly confirms this by stating that realtime, continuous monitoring of railway car components is performed. *Id.*, [0046]. Therefore, it is my opinion that a POSITA would understand that

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Armitage's sensors are never placed in a standby state and/or periodically awakened to collect and transmit readings as required by independent claim 1. It is also my opinion that a POSITA would recognize that attempting to modify Armitage using LeFebvre's power management scheme would inhibit the critical realtime, continuous monitoring function of Armitage. A POSITA, then, would not be motivated to combine Armitage and LeFebvre in the manner Petitioner describes.

91. The deficiencies I discuss above are not cured by Denny or Provasnik. I first note that the Petition does not rely on Denny or Provasnik as disclosing limitation 1(g). In addition, Denny requires that the electronic circuit 50 always be active. Ex. 1008 at 7:14-19. Thus, the thermal warning device 10 is never placed in any standby state and periodically awakened to collect and transmit readings from the temperature sensor 16. Provasnik is silent regarding a "standby state", and it appears that the sensor device is always in an active state when in use.

92. It is my opinion that a POSITA would not be motivated to modify Armitage based on the teachings of LeFebvre to reach the subject matter of limitation 1(g) because of the significant differences in their sensor analysis techniques, as described above. Therefore, it is also my opinion that a POSITA

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would not find that claims 1 and 24 are obvious over Armitage in view of

LeFebvre, Denny, and Provasnik.

VII. CONCLUDING STATEMENT

93. Relying on my education, experience, skill, and training in the relevant field of art, and after reviewing the materials identified above, it is my opinion that Petitioner has not established that any of the Challenged Claims is invalid.

94. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination remotely within the United States during the time allotted for such cross-examination at a time and place agreed by counsel.

95. I reserve the right to supplement my opinions in the future to respond to any arguments that Petitioner raises and to take into account new information as it becomes available to me.

96. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false

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statements and the like so made are punishable by fine or imprisonment, or both,
under Section 1001 of Title 18 of the United States Code.

Executed October 6, 2023 at Pittsburgh, Pennsylvania.

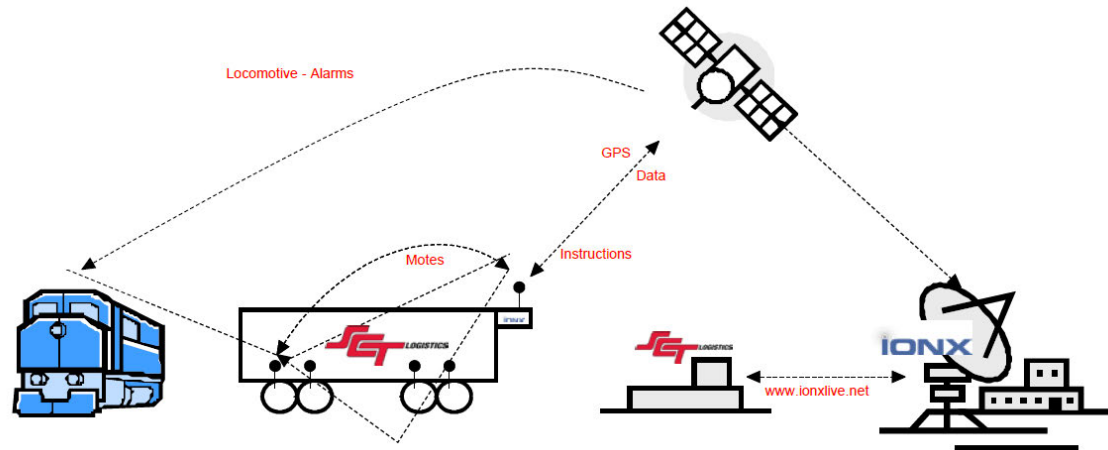
Michael I. Shamos

Appendix A

U.S. Patent No. 9,365,223	Conception
2. A system for monitoring a railcar, comprising:	The diagram illustrates a railcar monitoring system. On the left, a blue locomotive is shown. In the center, a white railcar with 'ST LOGISTICS' branding is depicted, equipped with several sensors labeled 'Motes'. Above the railcar, a GPS satellite is shown. To the right, a ground station with a large parabolic antenna is labeled 'IONX'. A dashed line connects the locomotive to the railcar, labeled 'Locomotive - Alarms'. A dashed line connects the railcar to the GPS satellite, labeled 'GPS Data'. A dashed line connects the railcar to the ground station, labeled 'Instructions'. A dashed line connects the ground station to the GPS satellite. A dashed line connects the ground station to a computer icon labeled 'www.ionxlive.net'. See Exhibit 2020, dated April 4, 2010; Slide 2.

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a plurality of sensor devices located on the railcar for monitoring parameters or conditions of the railcar, each of said sensor devices being separate from one another and including a sensor for monitoring one of said parameters or conditions of the railcar;



See Exhibit 2020, dated April 4, 2010; Slide 2.



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“4 bolt attached sensor (for smaller bearing end caps)”



“2 bolt attached sensor (for larger bearing end caps)”

See Exhibit 2020, dated April 4, 2010; Slide 3.

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See Exhibit 2017, dated 2010-03-21; slide 8; 2018 (metadata corroborating date)

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said plurality of sensor devices including at least one temperature sensor device having:

a housing;

a temperature sensor in thermal communication with an item of the railcar for which the temperature is being monitored, which item is external to said housing;

electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing;

a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing;

a communication device capable of broadcasting information regarding

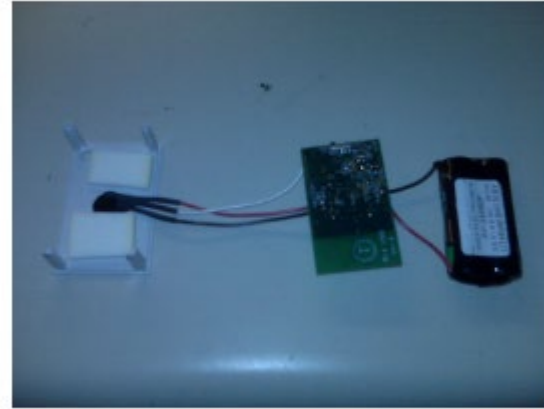
1) Components you will need:

QTY	DESCRIPTION	UNIT		VENDOR	Vendor Part #	REV
1	PCBA, WSN-102	EA	MTS	SMT		8
1	Enclosure, WSN-1xx, Lid	EA	MTS	Protomold	063009WSNEL101-10	10
1	Enclosure, WSN-1xx, Base	EA	MTS	Protomold	063009WSNEB101-10	10
1	Brass Plug	EA	MTS	Hillside	062509WSNEP101-01	1
1	Battery pack, 2AA	EA	MTS	AVEX Electronics	AV-3398BP	
2	Wire, 26AWG, 7/24, PVC, white	IN	MTS	Alpha Wire	3049 WH005	
2	Wire, 26AWG, 7/24, PVC, red	IN	MTS	Alpha Wire	3049 RD005	
2	Wire, 26AWG, 7/24, PVC, black	IN	MTS	Alpha Wire	3049 BK005	
1	IC, temperature sensor, MCP9700A, TO-92	EA	OTS	Microchip	MCP9700A-E/TO	
1.5	Heat Shrink, 3/32"ID	IN	OTS	3M	VFP-876	
3	Double stick tape, 1" x 0.0625"	IN	OTS	3M	VHB 4657F	
1	Tape, electrical, 3/4" WD	IN	OTS	3M	Super 33+	
1	Label, IONX logo, for WSN101, 1"x2"	EA	MTS	any		
30	Potting material	GR	OTS	Sparta Polymers	HT1201	
1	Epoxy, thermal	ML	OTS	Resin Technology Group	KONA 870 FTLV-DP	

See Exhibit 2092 at 1, dated December 3, 2009; Exhibit 2168 (corroborating date).

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the temperature sensed via wireless communication, said communication device positioned within said housing; and



See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).



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“4 bolt attached sensor (for smaller bearing end caps)”



“2 bolt attached sensor (for larger bearing end caps)”

See Exhibit 2020, dated April 4, 2010; Slide 3.

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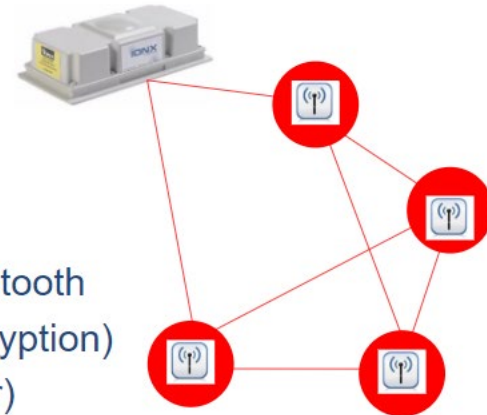


See Exhibit 2017, dated 2010-03-21; slide 8; 2018 (metadata corroborating date)

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Series 3 - Wireless car-based network

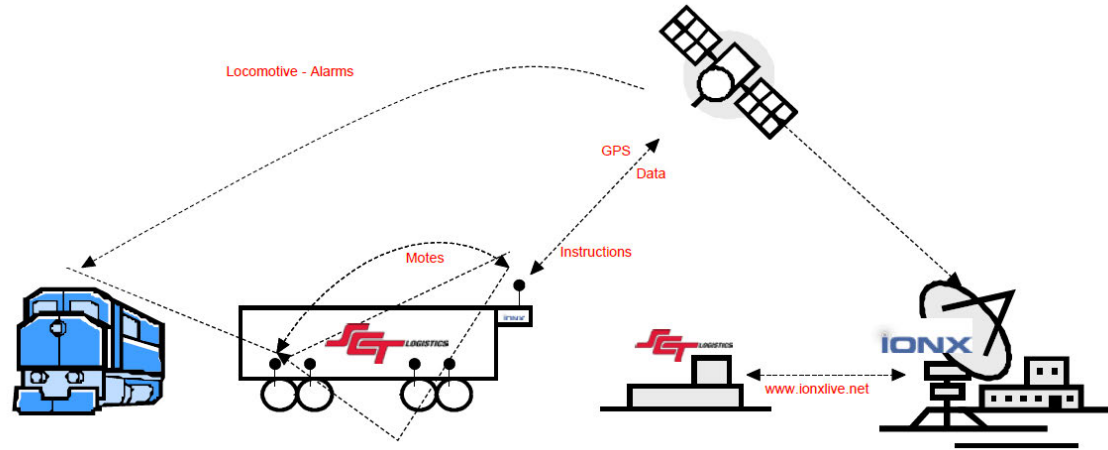
Radio off most of time
Redundant paths (mesh)
Scalable
Frequency Agile
Coexistence with Wi-Fi & Bluetooth
Secure (access control & encryption)
Intelligent routing (node power)



See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

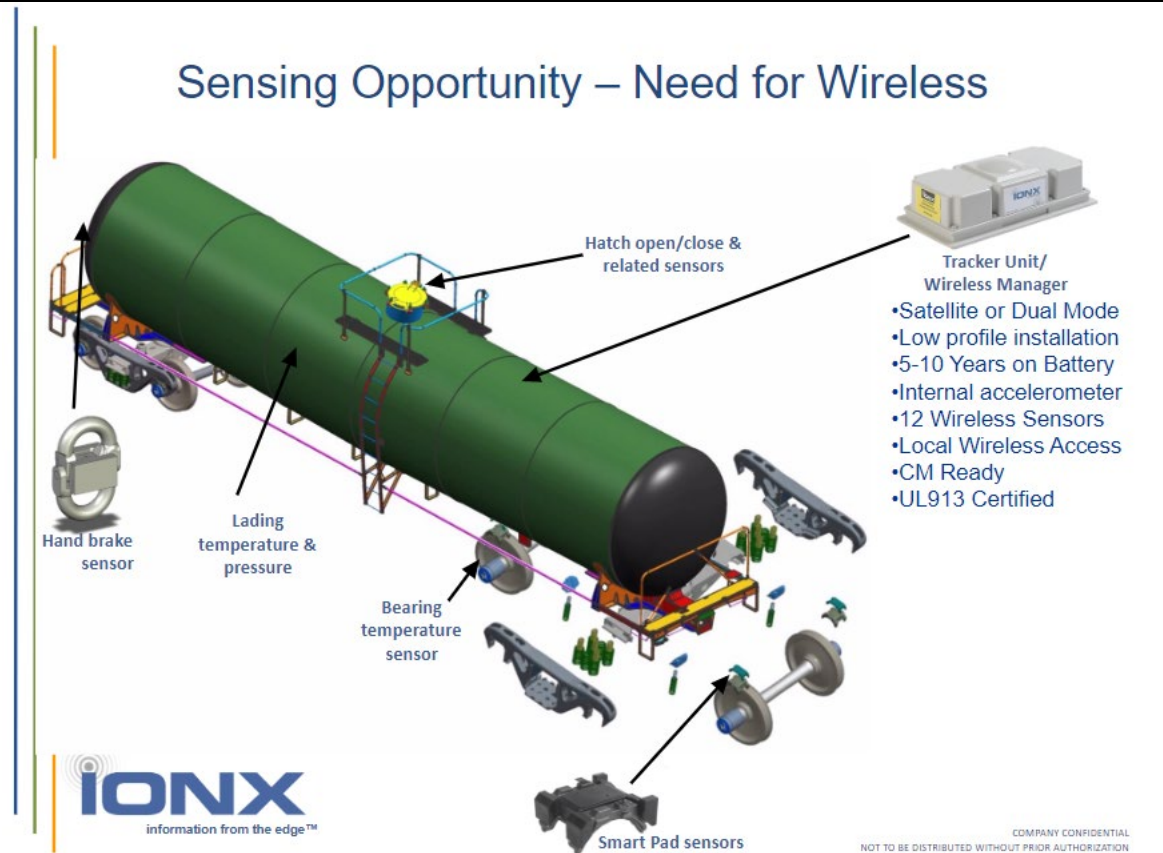
Declaration of Michael I. Shamos
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a communication management unit, mounted on the railcar, capable of two way wireless communication with each of said plurality of sensor devices for receiving information therefrom, said communication management unit having a wireless communication device for broadcasting information about the parameter or condition being monitored.



See Exhibit 2020, dated April 4, 2010; Slide 2.

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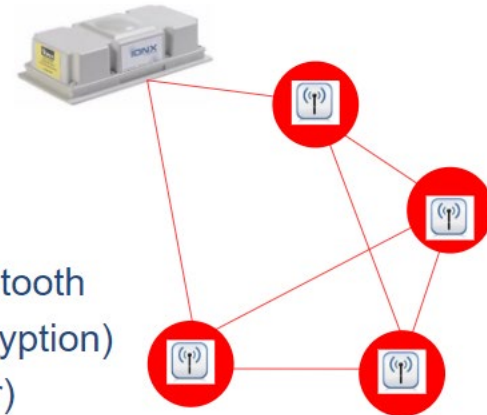


See Exhibit 2017, dated 2010-03-21; slide 8; 2018 (metadata corroborating date)

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Series 3 - Wireless car-based network

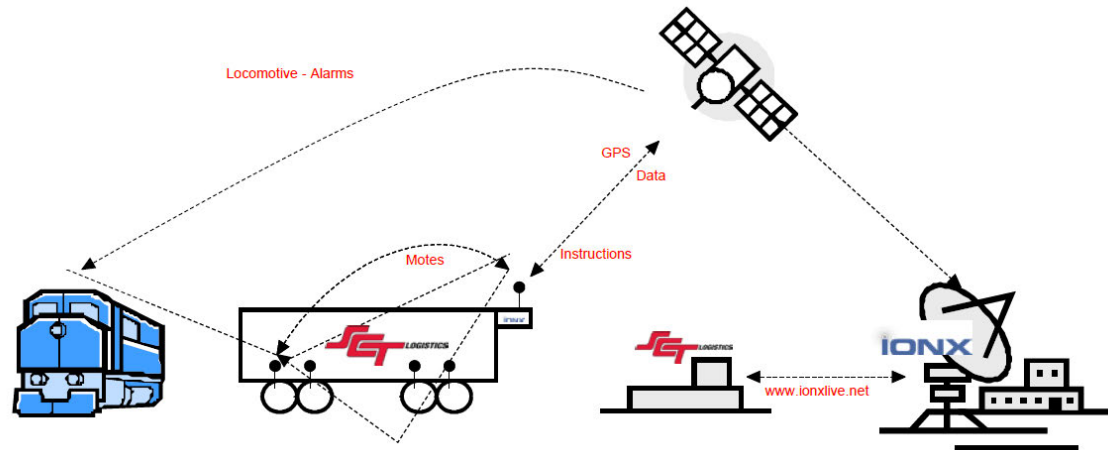
Radio off most of time
Redundant paths (mesh)
Scalable
Frequency Agile
Coexistence with Wi-Fi & Bluetooth
Secure (access control & encryption)
Intelligent routing (node power)



See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

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3. The system of claim 2 wherein said communication management unit can make a determination of an alarm condition based on data collected by two or more of said sensor devices.

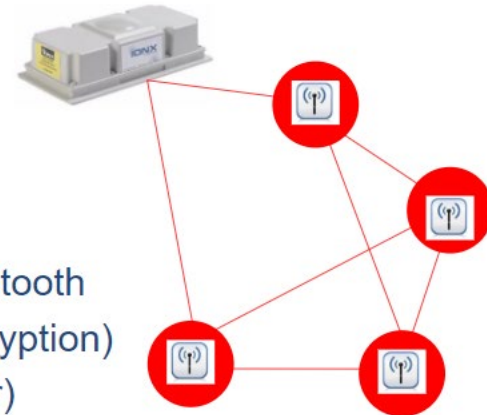


See Exhibit 2020, dated April 4, 2010; Slide 2.

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Series 3 - Wireless car-based network

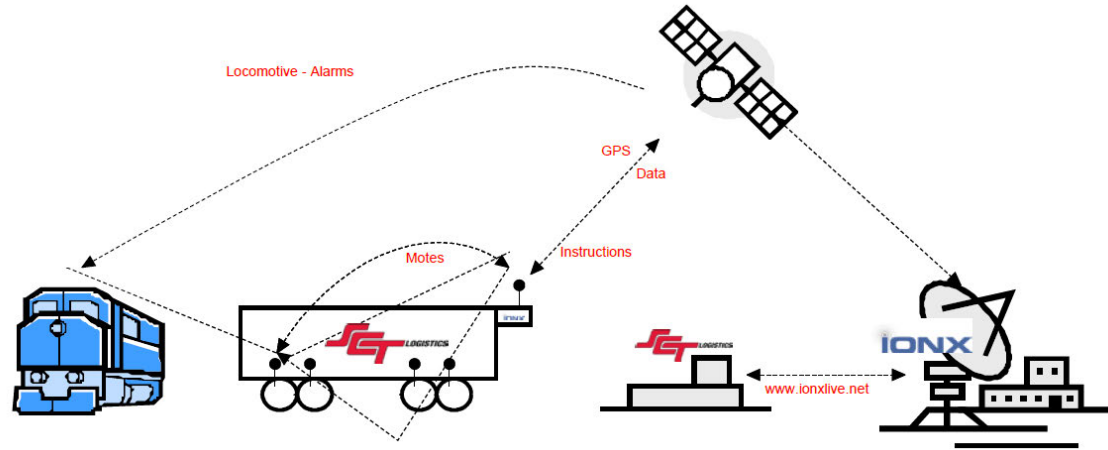
Radio off most of time
Redundant paths (mesh)
Scalable
Frequency Agile
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Secure (access control & encryption)
Intelligent routing (node power)



See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

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4. The system of claim 2 wherein each of said plurality of sensor devices is capable of exchanging data with other of said plurality of sensor devices and with said communication management unit.

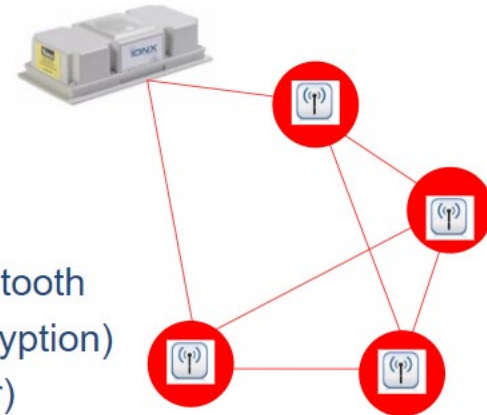


See Exhibit 2020, dated April 4, 2010; Slide 2.

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Series 3 - Wireless car-based network

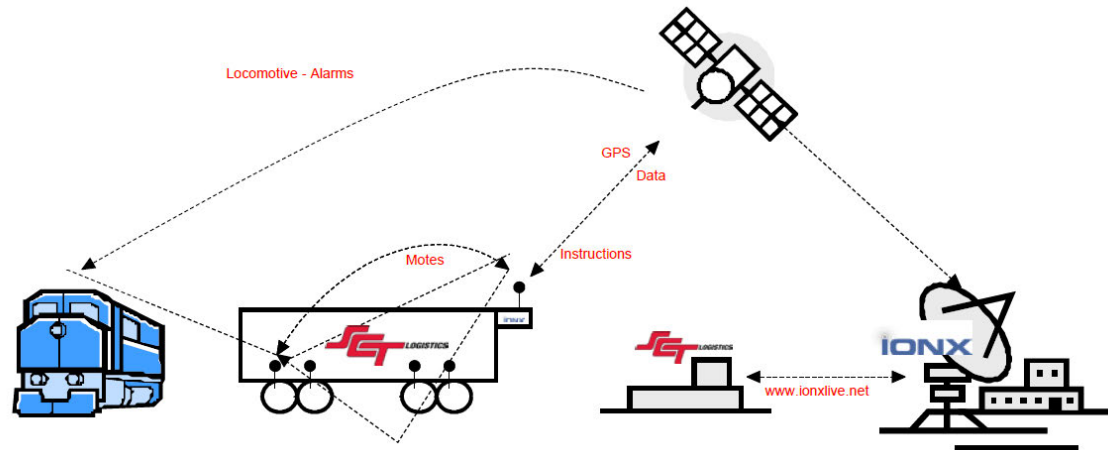
Radio off most of time
Redundant paths (mesh)
Scalable
Frequency Agile
Coexistence with Wi-Fi & Bluetooth
Secure (access control & encryption)
Intelligent routing (node power)



See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

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5. A system for monitoring the operation of a railcar comprising:



See Exhibit 2020, dated April 4, 2010; Slide 2.

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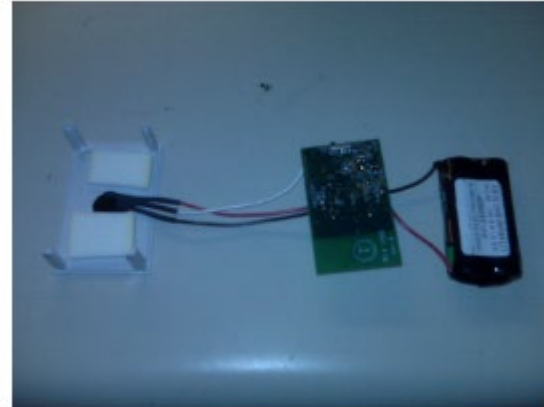
a. one or more sensor units mounted on said railcar, each of said sensor units monitoring an operating parameter of said railcar wherein each of said sensor units comprises a sensor, a power source, a processor, memory, communications circuitry, and software, stored in said memory and executed by said processor, said software performing the functions of collecting data from said sensor at periodic intervals; and

1) Components you will need:

QTY	DESCRIPTION	UNIT		VENDOR	Vendor Part #	REV
1	PCBA, WSN-102	EA	MTS	SMT		8
1	Enclosure, WSN-1xx, Lid	EA	MTS	Protomold	063009WSNEL101-10	10
1	Enclosure, WSN-1xx, Base	EA	MTS	Protomold	063009WSNEB101-10	10
1	Brass Plug	EA	MTS	Hillside	062509WSNEP101-01	1
1	Battery pack, 2AA	EA	MTS	AVEX Electronics	AV-3398BP	
2	Wire, 26AWG, 7/24, PVC, white	IN	MTS	Alpha Wire	3049 WH005	
2	Wire, 26AWG, 7/24, PVC, red	IN	MTS	Alpha Wire	3049 RD005	
2	Wire, 26AWG, 7/24, PVC, black	IN	MTS	Alpha Wire	3049 BK005	
1	IC, temperature sensor, MCP9700A, TO-92	EA	OTS	Microchip	MCP9700A-E/TO	
1.5	Heat Shrink, 3/32"ID	IN	OTS	3M	VFP-876	
3	Double stick tape, 1" x 0.0625"	IN	OTS	3M	VHB 4657F	
1	Tape, electrical, 3/4" WD	IN	OTS	3M	Super 33+	
1	Label, IONX logo, for WSN101, 1"x2"	EA	MTS	any		
30	Potting material	GR	OTS	Sparta Polymers	HT1201	
1	Epoxy, thermal	ML	OTS	Resin Technology Group	KONA 870 FTLV-DP	

See Exhibit 2092 at 1, dated December 3, 2009; Exhibit 2168 (corroborating date).

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See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).

2.1.1 Wireless Sensor Node (WSN) (on Bearing Adapter)

- Type: Integrated temperature sensor
- Model: WSN101 (see Figure 1)
- Quantity: 9 per wagon x 10 wagons = 90 total
- Dimensions: 40mm x 88mm x 34mm
- Power source: self-contained high-performance battery (2-5 year life expectancy)
- Mounting method: thermally conductive epoxy adhesive and mechanical fastener
- Mounting locations:
 - Bearing temperature nodes: One on each bearing adapter, aligned with the wagon longitudinal axis on the inboard surface. Eight nodes per wagon. See red location indicator in Figure 2.
 - Ambient temperature node: One on the undercarriage of the wagon subjected to airflow, likely the underside of the sill. Exact location determined upon wagon inspection. One node per wagon.

Exhibit 2162 at 4, dated December 21, 2009.

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2.1.5 Electrical and Communication Block Diagram (simplified)

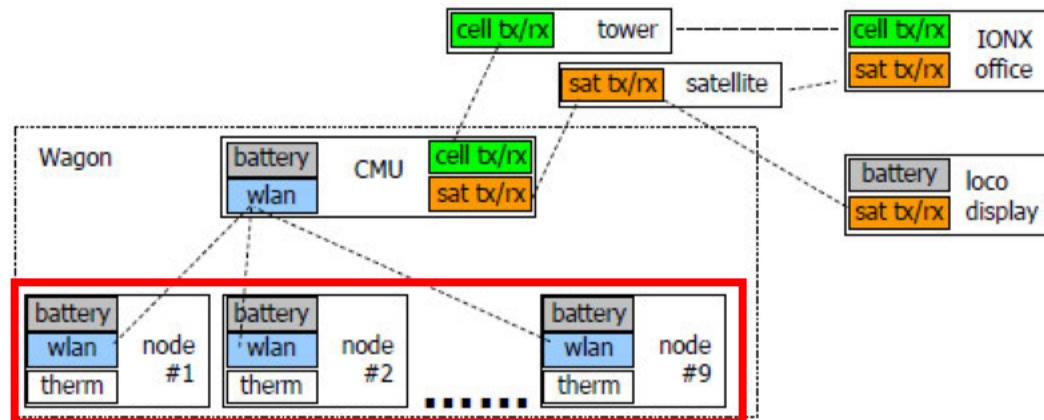
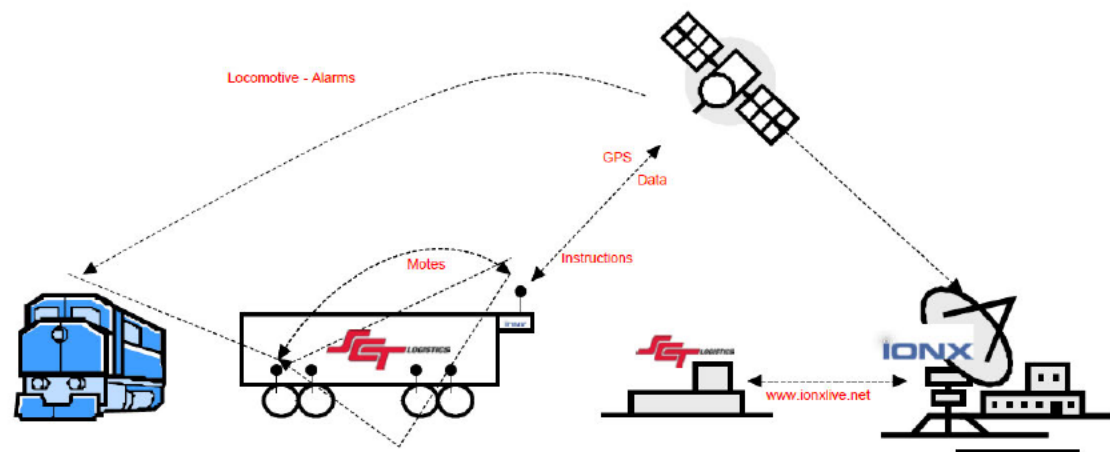


Exhibit 2162 at 6, dated December 21, 2009.



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See Exhibit 2020, dated April 4, 2010; Slide 2.



“4 bolt attached sensor (for smaller bearing end caps)”



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“2 bolt attached sensor (for larger bearing end caps)”

See Exhibit 2020, dated April 4, 2010; Slide 3.



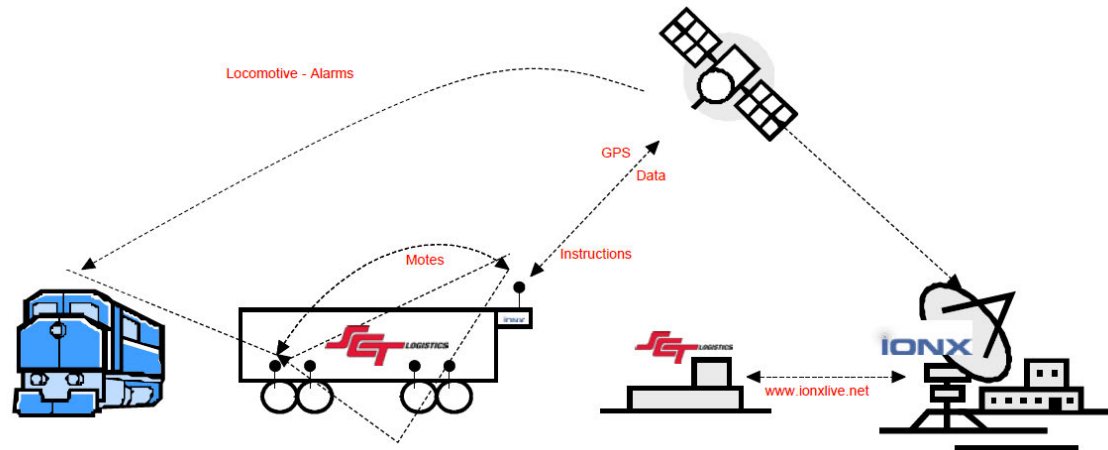
See Exhibit 2017, dated 2010-03-21; slide 8; 2018 (metadata corroborating date)

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b. a communication management unit, mounted on said railcar, said communication management unit in wireless communication with said one or more sensor units;



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See Exhibit 2020, dated April 4, 2010; Slide 2.

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wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor units (a) to determine if an actual failure exists and (b) to predict potential or imminent failures based on a statistical analysis of said collected data.	“ ...Put simply, prior to the trip we had alarm levels set at temperatures that didn’t take into account the Australian rail network and its ability to handle trackside maintenance. We realized during the trip that setting locomotive alarm thresholds at values that are sub-critical will lead to too many stoppages and delays along the single-track route to or from Perth. As such, we are recommending for your input revised threshold values so that only actionable messages are sent through to the locomotive; meaning, only those alarm levels that will require the crew to take action.” See 3/31/2010 email from Brent Wilson to Ron Bury attaching a letter that described revised alarm notification system, and attached letter discussing pre-programmed temperatures or “thresholds”. Exhibit 2019 “Stage 1: Bearing Trending -Alarm to IONX only. -Will be removed from locomotive display terminals - Will be used for trending recommendations and repeat offender identifications Stage 2: “Axle Differential Alarm” -Action: Stop train, check journal of alarmed bearing. Look for signs the bearing is “walking off” the axle or grease is being purged.
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	-Proceed at reduced speed of 60 kph maximum until stage 2 alarm clear message is received at locomotive terminal -If stage 2 alarm clear message is received at the locomotive terminal, proceed as normal Stage 3: “Above Ambient Alarm” -Action: Stop train, check journal of alarming bearing. Look for signs the bearing is “walking off” the axle or grease is being purged -Proceed at reduced speed of 30 kph maximum until stage 3 alarm clear message is received at the locomotive terminal at which point speed can be increased to 60 kph. -If the alarm message does not clear, a choice can be made to remove and change the bearing at an appropriate stoppage point, otherwise reduced speeds are required to reduce the chance of a screwed journal. -If Stage 2 and Stage 3 alarm clear messages are both received at the locomotive terminal, proceed as normal Stage 4: “Bearing Temp Alarm” -Action: Stop train, remove bearing.” See Exhibit 2020, dated April 4, 2010; Slide 8.
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6. The system of claim 5 wherein said determination of an alarm condition can be made by one of said sensor units.

Old Thresholds



New Thresholds



Exhibit 2032 at 2, dated April 12, 2010.

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7. The system of claim 5 wherein said determination of an alarm condition can be made by said communication management unit based on data collected by two or more of said sensor units.	“ ...Put simply, prior to the trip we had alarm levels set at temperatures that didn’t take into account the Australian rail network and its ability to handle trackside maintenance. We realized during the trip that setting locomotive alarm thresholds at values that are sub-critical will lead to too many stoppages and delays along the single-track route to or from Perth. As such, we are recommending for your input revised threshold values so that only actionable messages are sent through to the locomotive; meaning, only those alarm levels that will require the crew to take action.” See 3/31/2010 email from Brent Wilson to Ron Bury attaching a letter that described revised alarm notification system, and attached letter discussing pre-programmed temperatures or “thresholds”. Exhibit 2019 “Stage 1: Bearing Trending -Alarm to IONX only. -Will be removed from locomotive display terminals - Will be used for trending recommendations and repeat offender identifications Stage 2: “Axle Differential Alarm” -Action: Stop train, check journal of alarmed bearing. Look for signs the bearing is “walking off” the axle or grease is being purged.
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	-Proceed at reduced speed of 60 kph maximum until stage 2 alarm clear message is received at locomotive terminal -If stage 2 alarm clear message is received at the locomotive terminal, proceed as normal Stage 3: “Above Ambient Alarm” -Action: Stop train, check journal of alarming bearing. Look for signs the bearing is “walking off” the axle or grease is being purged -Proceed at reduced speed of 30 kph maximum until stage 3 alarm clear message is received at the locomotive terminal at which point speed can be increased to 60 kph. -If the alarm message does not clear, a choice can be made to remove and change the bearing at an appropriate stoppage point, otherwise reduced speeds are required to reduce the chance of a screwed journal. -If Stage 2 and Stage 3 alarm clear messages are both received at the locomotive terminal, proceed as normal Stage 4: “Bearing Temp Alarm” -Action: Stop train, remove bearing.” See Exhibit 2020, dated April 4, 2010; Slide 8.
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	<i>Old Thresholds</i> <i>New Thresholds</i> Exhibit 2032 at 2, dated April 12, 2010.
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8. The system of claim 5 wherein each of said sensor units comprises:

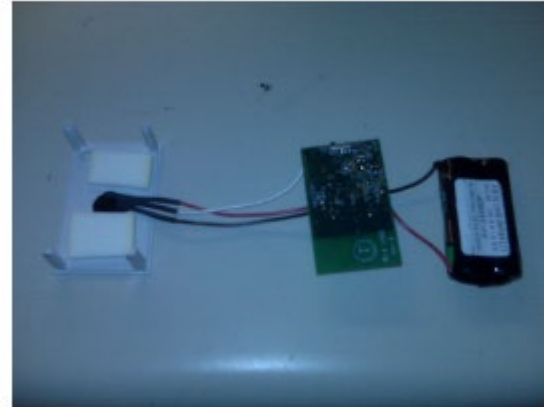
- a. a sensor;
- b. a power source;
- c. a processor;
- d. memory;
- e. communications circuitry; and
- f. software, stored in said memory and executed by said processor, said software performing the functions of collecting data from said sensor at periodic intervals.

1) Components you will need:

QTY	DESCRIPTION	UNIT		VENDOR	Vendor Part #	REV
1	PCBA, WSN-102	EA	MTS	SMT		8
1	Enclosure, WSN-1xx, Lid	EA	MTS	Protomold	063009WSNEL101-10	10
1	Enclosure, WSN-1xx, Base	EA	MTS	Protomold	063009WSNEB101-10	10
1	Brass Plug	EA	MTS	Hillside	062509WSNEP101-01	1
1	Battery pack, 2AA	EA	MTS	AVEX Electronics	AV-3398BP	
2	Wire, 26AWG, 7/24, PVC, white	IN	MTS	Alpha Wire	3049 WH005	
2	Wire, 26AWG, 7/24, PVC, red	IN	MTS	Alpha Wire	3049 RD005	
2	Wire, 26AWG, 7/24, PVC, black	IN	MTS	Alpha Wire	3049 BK005	
1	IC, temperature sensor, MCP9700A, TO-92	EA	OTS	Microchip	MCP9700A-E/TO	
1.5	Heat Shrink, 3/32"ID	IN	OTS	3M	VFP-876	
3	Double stick tape, 1" x 0.0625"	IN	OTS	3M	VHB 4657F	
1	Tape, electrical, 3/4" WD	IN	OTS	3M	Super 33+	
1	Label, IONX logo, for WSN101, 1"x2"	EA	MTS	any		
30	Potting material	GR	OTS	Sparta Polymers	HT1201	
1	Epoxy, thermal	ML	OTS	Resin Technology Group	KONA 870 FTLV-DP	

See Exhibit 2092 at 1, dated December 3, 2009; Exhibit 2168 (corroborating date).

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See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).

2.1.1 Wireless Sensor Node (WSN) (on Bearing Adapter)

- Type: Integrated temperature sensor
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- Quantity: 9 per wagon x 10 wagons = 90 total
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- Mounting method: thermally conductive epoxy adhesive and mechanical fastener
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Exhibit 2162 at 4, dated December 21, 2009.

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2.1.5 Electrical and Communication Block Diagram (simplified)

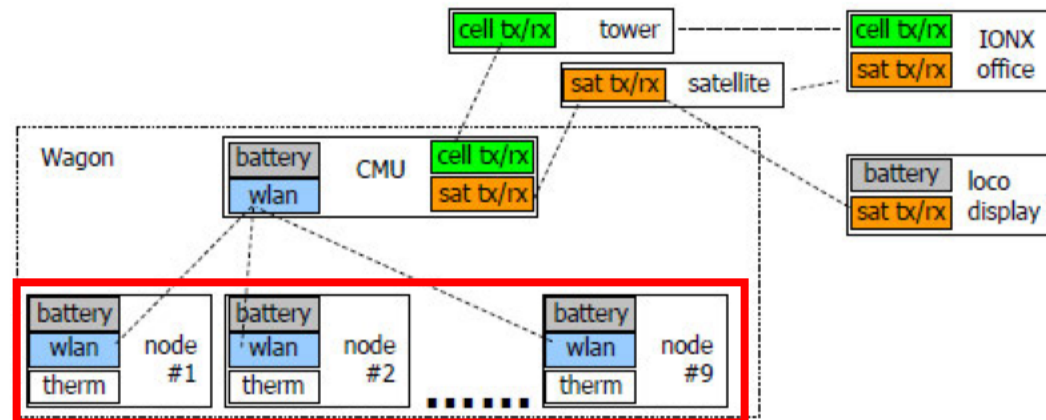
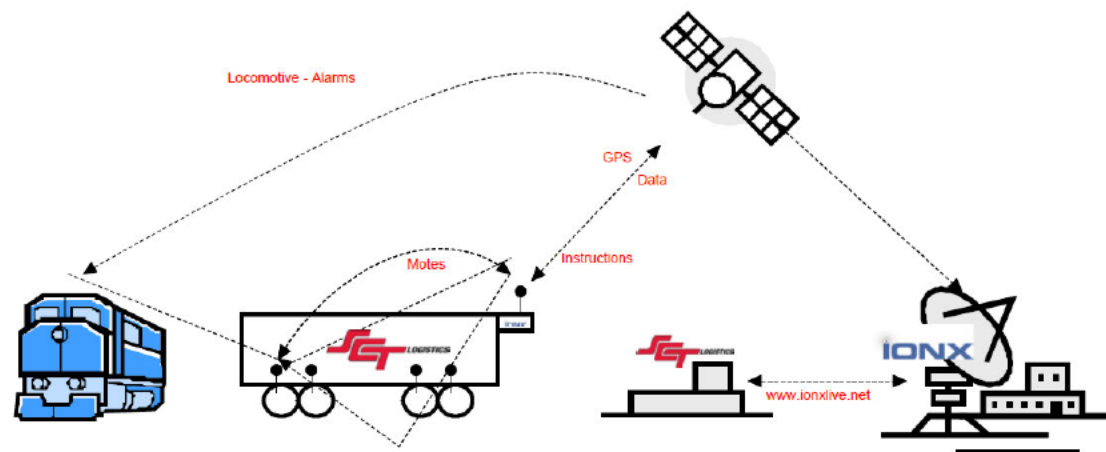


Exhibit 2162 at 6, dated December 21, 2009.



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See Exhibit 2020, dated April 4, 2010; Slide 2.



“4 bolt attached sensor (for smaller bearing end caps)”



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“2 bolt attached sensor (for larger bearing end caps)”

See Exhibit 2020, dated April 4, 2010; Slide 3.



See Exhibit 2017, dated 2010-03-21; slide 8; 2018 (metadata corroborating date)

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9. The system of claim 8 wherein said software further performs the function of:	
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assessing the collected data to determine if an alarm condition exists; and

communicating said alarm condition to said communication management unit via said communications circuitry; and

managing the power consumption of said sensor unit by placing said sensor unit in a standby state and periodically awakening said sensor unit to collect data from said sensor and to transmit information regarding said operating parameter to said communication management unit via said communication circuitry.

Old Thresholds



New Thresholds



Exhibit 2032 at 2, dated April 12, 2010.

“Power management: “wake/sleep” mode - The Edge asset monitoring system uses proprietary power management that minimizes the draw on the batteries. The communication management unit (CMU) has a defined message reporting schedule. When a message is scheduled to be generated and sent, the CMU powers on (wakes) to get location and other information from the sensors then transmits to the satellite. The CMU then powers off (sleeps) until its next scheduled power-on or wake-up period.”

See June 2, 2010 email from Andrew Martin to Constantine Tarawneh and Brent Wilson, attaching Glossary of Terms dated September 18, 2008. Exhibits 2047, 2090 (metadata corroborating date)

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10. The system of claim 5 wherein said one or more sensor units and said communication management unit are in wireless communication with each other and form a local area wireless network for said railcar.

2.1.5 Electrical and Communication Block Diagram (simplified)

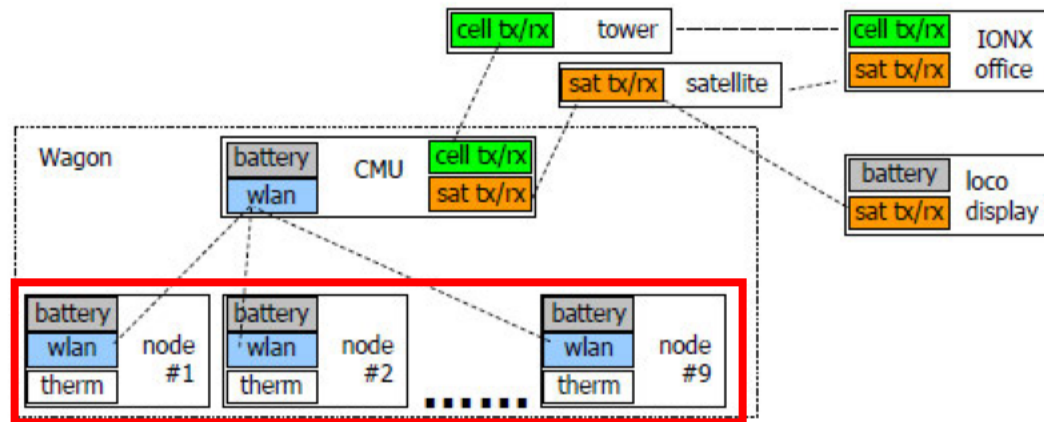
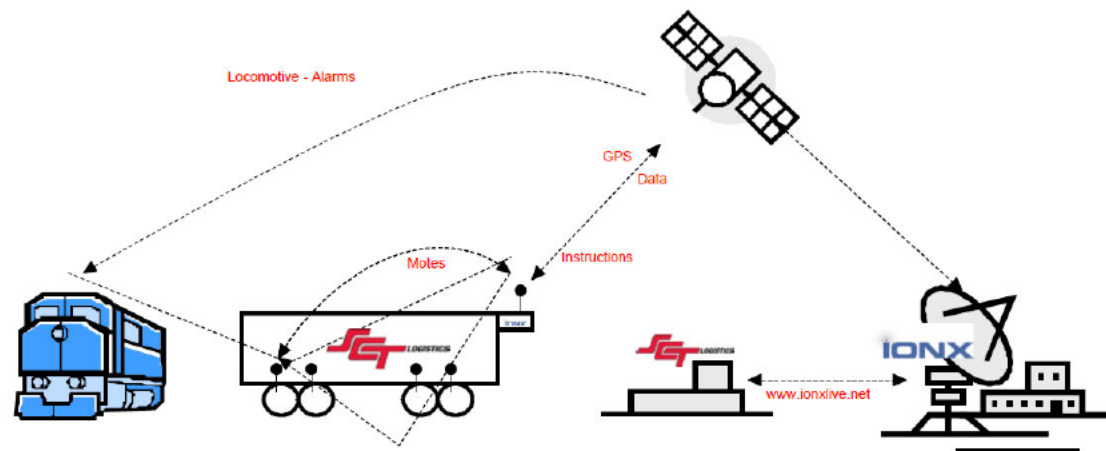


Exhibit 2162 at 6, dated December 21, 2009.

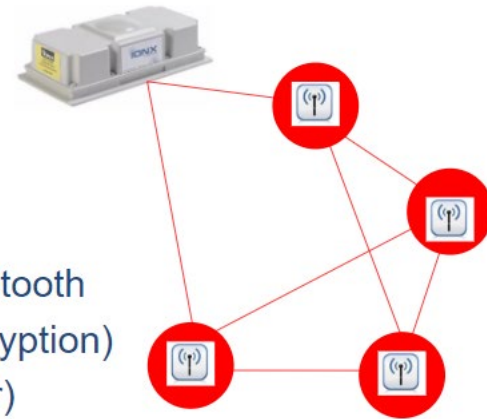


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See Exhibit 2020, dated April 4, 2010; Slide 2.

Series 3 - Wireless car-based network

Radio off most of time
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Secure (access control & encryption)
Intelligent routing (node power)



See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

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13. The system of claim 5 further comprising a base unit, said base unit being in wireless communication with said communication management unit, said based unit performing the functions of:

2.1.5 Electrical and Communication Block Diagram (simplified)

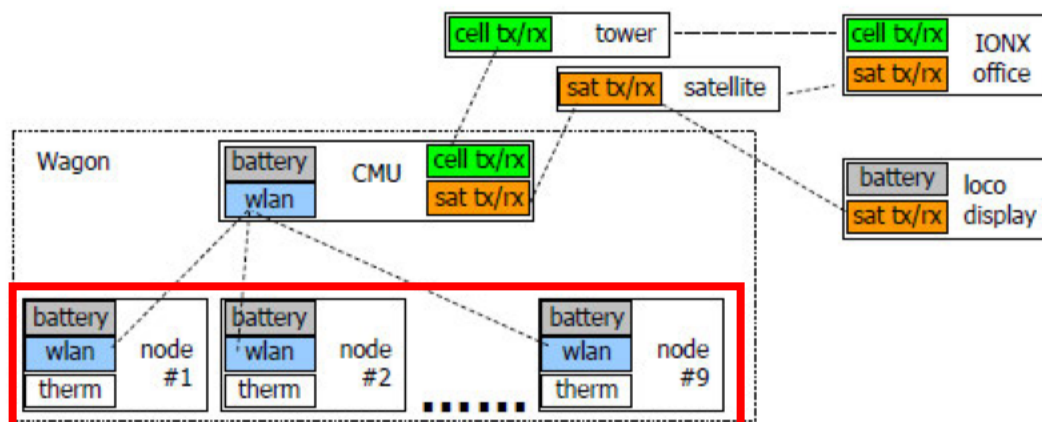
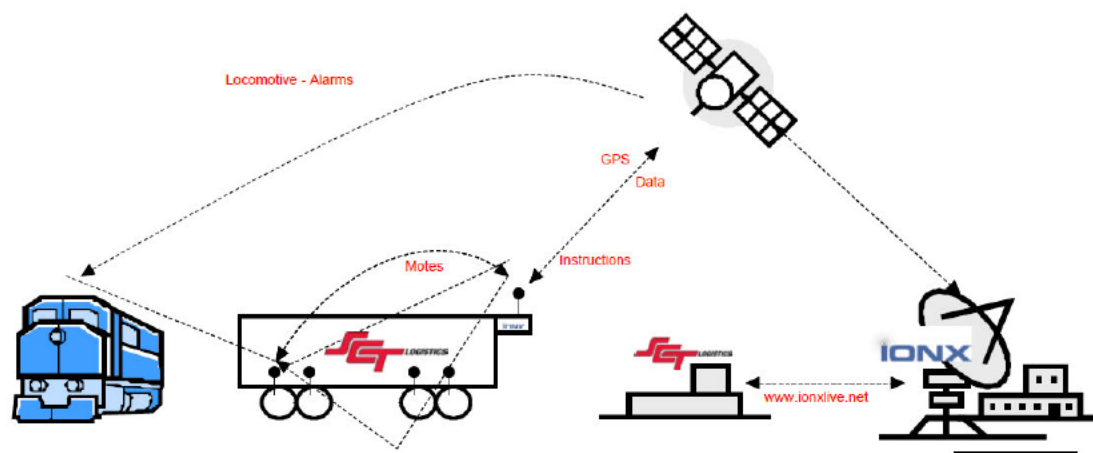


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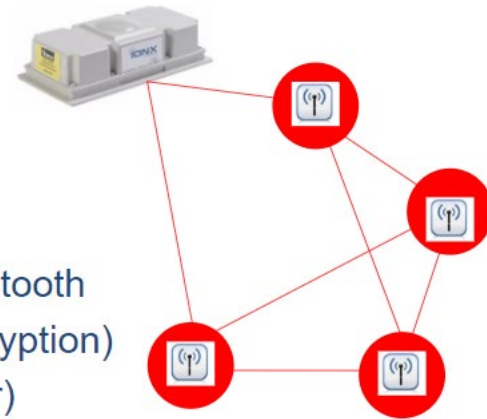


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Series 3 - Wireless car-based network

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See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

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a. collecting data and alarms from said communication management unit;

2.1.5 Electrical and Communication Block Diagram (simplified)

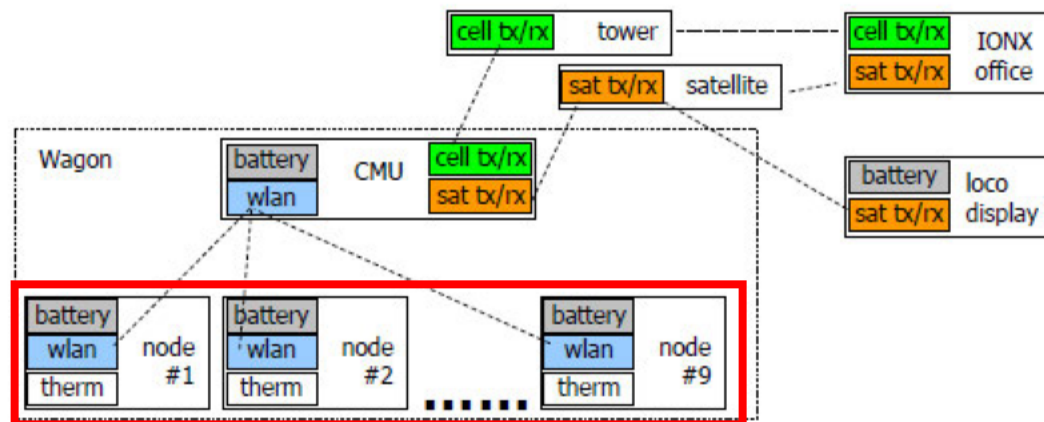
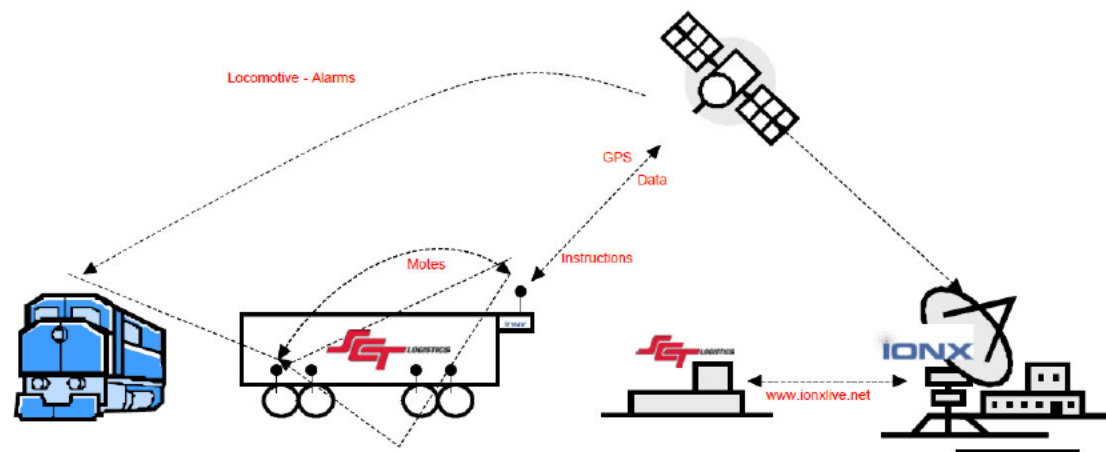


Exhibit 2162 at 6, dated December 21, 2009.

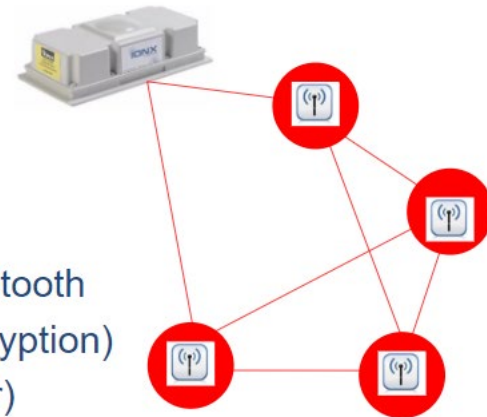


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See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

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b. displaying alarm conditions raised by said communication management unit; and

2.1.5 Electrical and Communication Block Diagram (simplified)

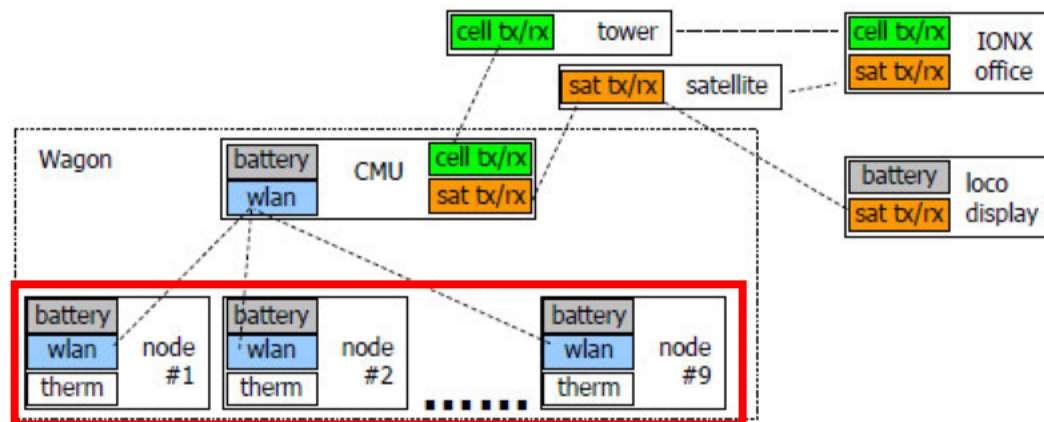
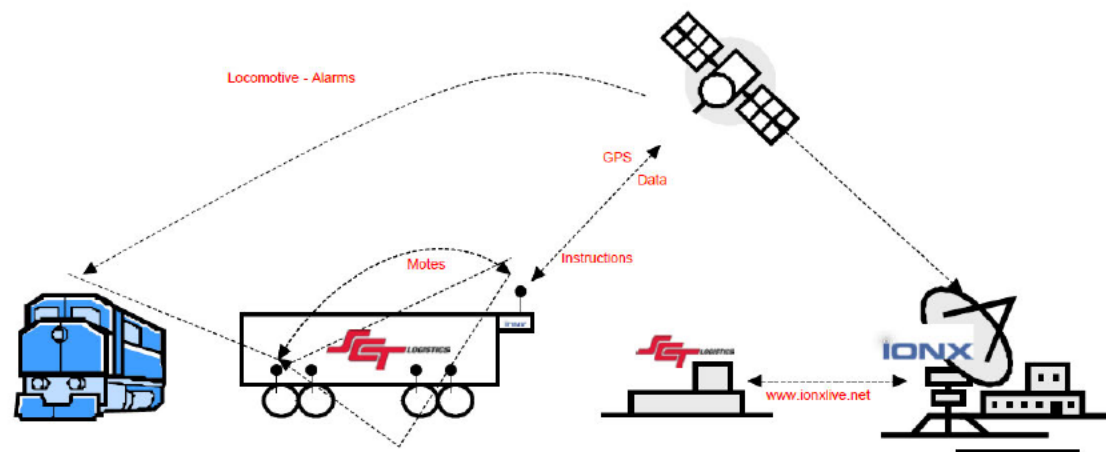


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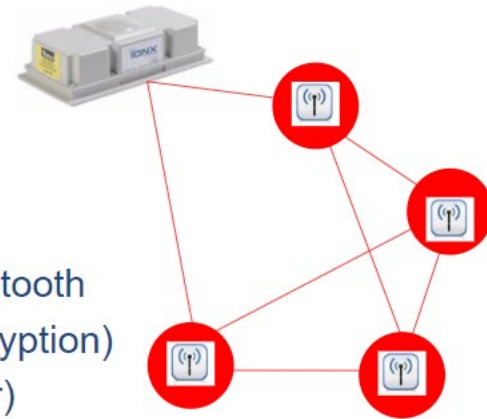


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See Exhibit 2020, dated April 4, 2010; Slide 2.

Series 3 - Wireless car-based network

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See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

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“Can we talk in the morning about how we can change the alarms that SCT sees on the website and at the locomotive display.”

See March 31, 2010 email from Andrew Martin (via Brent Wilson’s email address) to inventors and non-inventors. Ex. 2058.

Cab Display

Car Name

Affected
Bearing or Axle

Date and Time
Received

Return to Inbox



Alert Type

Temperature
of Bearing

Alert Message Details

See Ex 2020, dated April 4, 2010; Slide 7 (highlighting added).

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c. determining high level alarms based on data and alarms collected from said communication management unit.	“Stage 1: Bearing Trending -Alarm to IONX only. -Will be removed from locomotive display terminals - Will be used for trending recommendations and repeat offender identifications Stage 2: “Axle Differential Alarm” -Action: Stop train, check journal of alarmed bearing. Look for signs the bearing is “walking off” the axle or grease is being purged. -Proceed at reduced speed of 60 kph maximum until stage 2 alarm clear message is received at locomotive terminal -If stage 2 alarm clear message is received at the locomotive terminal, proceed as normal Stage 3: “Above Ambient Alarm” -Action: Stop train, check journal of alarming bearing. Look for signs the bearing is “walking off” the axle or grease is being purged -Proceed at reduced speed of 30 kph maximum until stage 3 alarm clear message is received at the locomotive terminal at which point speed can be increased to 60 kph.
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	-If the alarm message does not clear, a choice can be made to remove and change the bearing at an appropriate stoppage point, otherwise reduced speeds are required to reduce the chance of a screwed journal. -If Stage 2 and Stage 3 alarm clear messages are both received at the locomotive terminal, proceed as normal Stage 4: “Bearing Temp Alarm” -Action: Stop train, remove bearing.” See Exhibit 2020, dated April 4, 2010; Slide 8.
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14. The system of claim 13 wherein said base unit is in wireless communication with multiple communication management units.

2.1.5 Electrical and Communication Block Diagram (simplified)

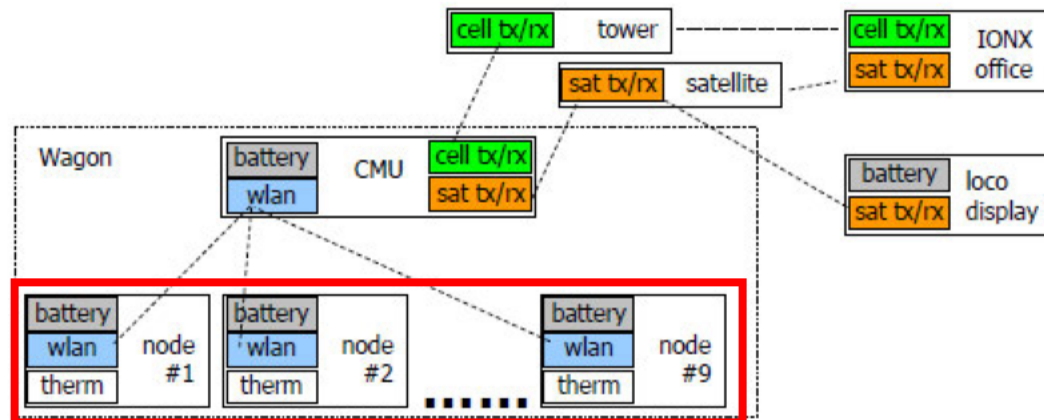
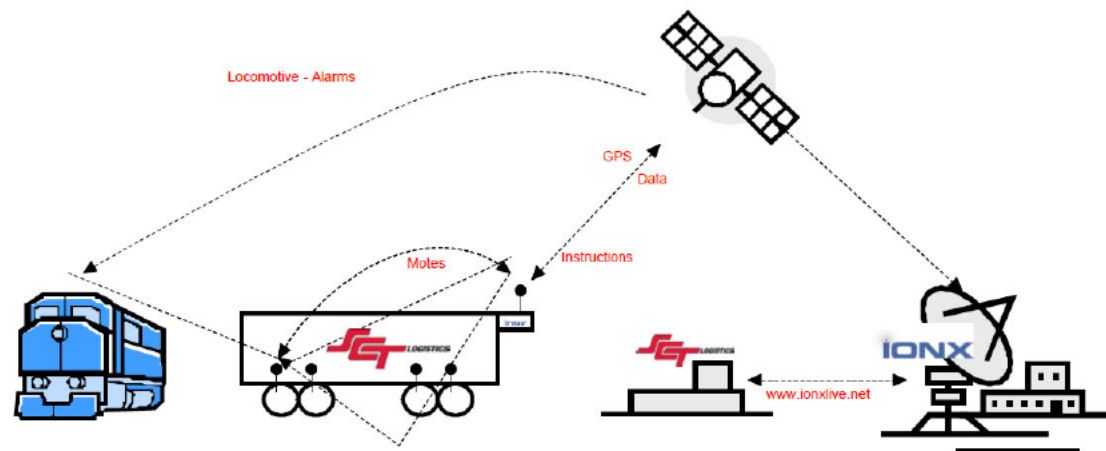


Exhibit 2162 at 6, dated December 21, 2009.

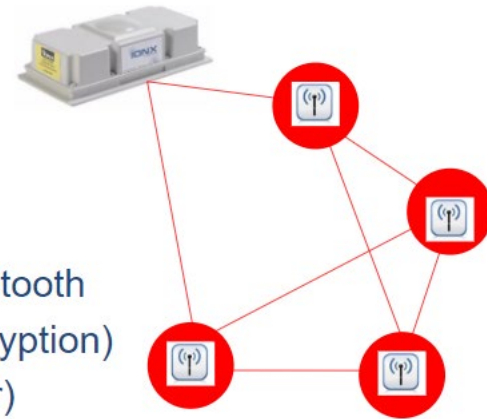


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See Exhibit 2020, dated April 4, 2010; Slide 2.

Series 3 - Wireless car-based network

Radio off most of time
Redundant paths (mesh)
Scalable
Frequency Agile
Coexistence with Wi-Fi & Bluetooth
Secure (access control & encryption)
Intelligent routing (node power)



See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

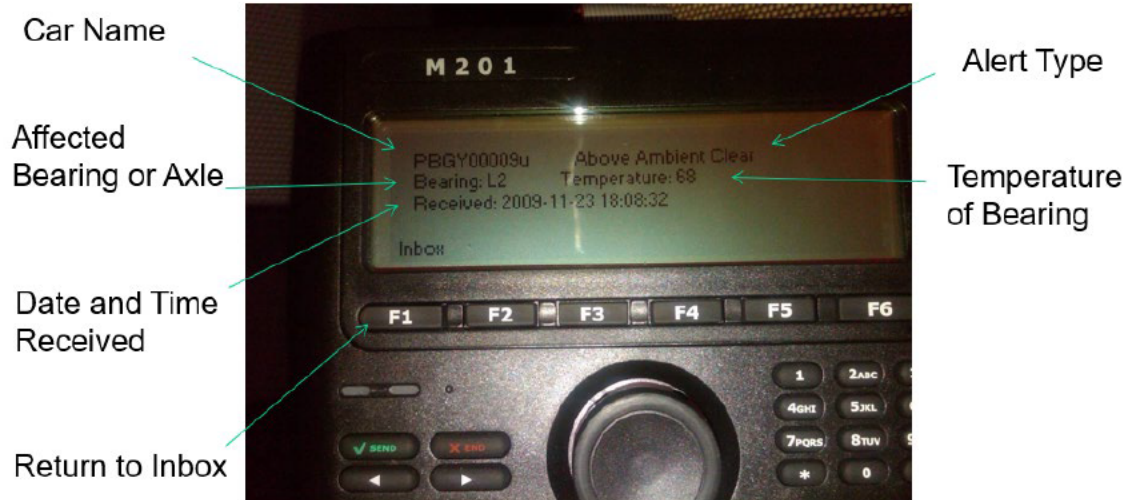
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“Can we talk in the morning about how we can change the alarms that SCT sees on the website and at the locomotive display.”

See March 31, 2010 email from Andrew Martin (via Brent Wilson’s email address) to inventors and non-inventors. Ex. 2058.

Cab Display



Alert Message Details

See Ex 2020, dated April 4, 2010; Slide 7 (highlighting added).

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	2.1.2 Communication Management Unit (CMU) (on Wagon) • Type/Model: 351i (see Figure 3) • Quantity: 1 per wagon x 10 wagons = 10 total • Dimensions: 365mm x 180mm x 67cm • Power source: self-contained high-performance battery (5-10 year life expectancy) • Mounting method: steel mounting plate welded to the wagon (see Figure 4) • Mounting location: top/end of wagon with top of CMU facing skyward (see Figure 5) Ex. 2162 at 6, dated December 12, 2009.
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15. The system of claim 14 wherein said base unit uses distributed event processing to perform trend analysis based on alarms and data collected from one or more communication management units to determine if a high level alarm should be raised.	“Stage 1: Bearing Trending -Alarm to IONX only. -Will be removed from locomotive display terminals - Will be used for trending recommendations and repeat offender identifications Stage 2: “Axle Differential Alarm” -Action: Stop train, check journal of alarmed bearing. Look for signs the bearing is “walking off” the axle or grease is being purged. -Proceed at reduced speed of 60 kph maximum until stage 2 alarm clear message is received at locomotive terminal -If stage 2 alarm clear message is received at the locomotive terminal, proceed as normal Stage 3: “Above Ambient Alarm” -Action: Stop train, check journal of alarming bearing. Look for signs the bearing is “walking off” the axle or grease is being purged -Proceed at reduced speed of 30 kph maximum until stage 3 alarm clear message is received at the locomotive terminal at which point speed can be increased to 60 kph.
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	-If the alarm message does not clear, a choice can be made to remove and change the bearing at an appropriate stoppage point, otherwise reduced speeds are required to reduce the chance of a screwed journal. -If Stage 2 and Stage 3 alarm clear messages are both received at the locomotive terminal, proceed as normal Stage 4: “Bearing Temp Alarm” -Action: Stop train, remove bearing.” See Exhibit 2020, dated April 4, 2010; Slide 8.
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16. The system of claim 14 wherein said base unit applies heuristics to data collected from said one or more communication management units to determine if a high level alarm should be raised.	“Stage 1: Bearing Trending -Alarm to IONX only. -Will be removed from locomotive display terminals - Will be used for trending recommendations and repeat offender identifications Stage 2: “Axle Differential Alarm” -Action: Stop train, check journal of alarmed bearing. Look for signs the bearing is “walking off” the axle or grease is being purged. -Proceed at reduced speed of 60 kph maximum until stage 2 alarm clear message is received at locomotive terminal -If stage 2 alarm clear message is received at the locomotive terminal, proceed as normal Stage 3: “Above Ambient Alarm” -Action: Stop train, check journal of alarming bearing. Look for signs the bearing is “walking off” the axle or grease is being purged -Proceed at reduced speed of 30 kph maximum until stage 3 alarm clear message is received at the locomotive terminal at which point speed can be increased to 60 kph.
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	-If the alarm message does not clear, a choice can be made to remove and change the bearing at an appropriate stoppage point, otherwise reduced speeds are required to reduce the chance of a screwed journal. -If Stage 2 and Stage 3 alarm clear messages are both received at the locomotive terminal, proceed as normal Stage 4: “Bearing Temp Alarm” -Action: Stop train, remove bearing.” See Exhibit 2020, dated April 4, 2010; Slide 8.
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17. The system of claim 16 wherein said base unit and said one or more communication management units communicate with each other via a satellite communications capability or a cellular network capability.

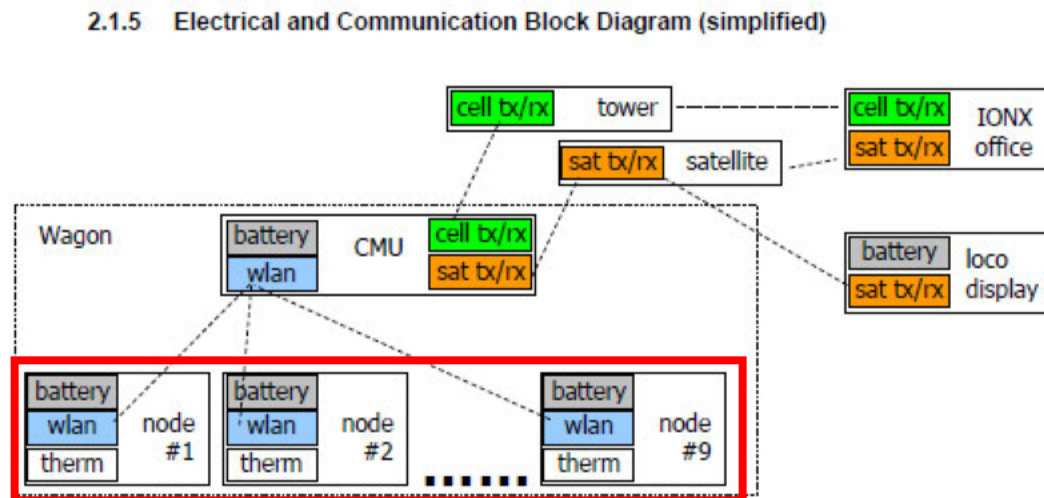
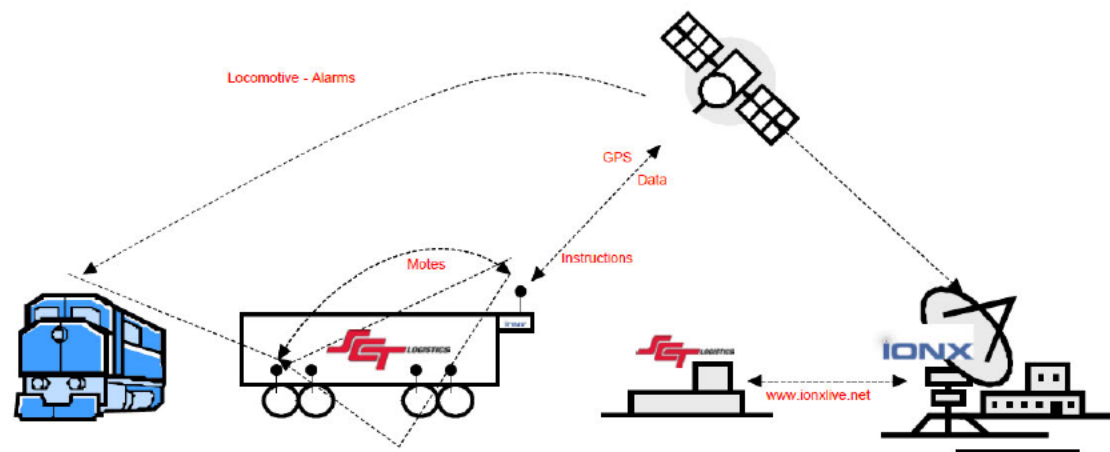


Exhibit 2162 at 6, dated December 21, 2009.



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	See Exhibit 2020, dated April 4, 2010; Slide 2.
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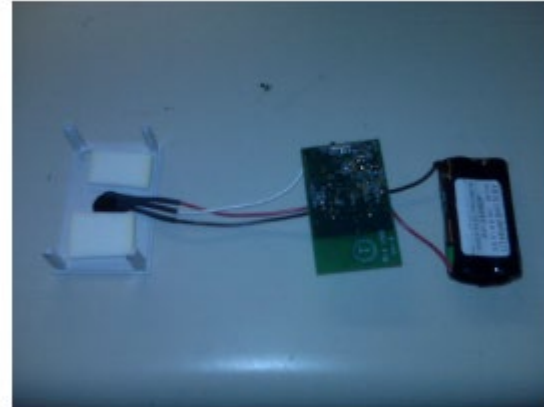
18. The system of claim 5 wherein said sensor is selected from a group consisting essentially of temperature sensors, pressure sensors, strain sensors, load cell sensors, hand brake position sensors, magnetic sensors, vibration sensors, gyroscopes, acceleration sensors, hall effect sensors, piezoelectric resistive microphones and switches.

1) Components you will need:

QTY	DESCRIPTION	UNIT		VENDOR	Vendor Part #	REV
1	PCBA, WSN-102	EA	MTS	SMT		8
1	Enclosure, WSN-1xx, Lid	EA	MTS	Protomold	063009WSNEL101-10	10
1	Enclosure, WSN-1xx, Base	EA	MTS	Protomold	063009WSNEB101-10	10
1	Brass Plug	EA	MTS	Hillside	062509WSNEP101-01	1
1	Battery pack, 2AA	EA	MTS	AVEX Electronics	AV-3398BP	
2	Wire, 26AWG, 7/24, PVC, white	IN	MTS	Alpha Wire	3049 WH005	
2	Wire, 26AWG, 7/24, PVC, red	IN	MTS	Alpha Wire	3049 RD005	
2	Wire, 26AWG, 7/24, PVC, black	IN	MTS	Alpha Wire	3049 BK005	
1	IC, temperature sensor, MCP9700A, TO-92	EA	OTS	Microchip	MCP9700A-E/TO	
1.5	Heat Shrink, 3/32"ID	IN	OTS	3M	VFP-876	
3	Double stick tape, 1" x 0.0625"	IN	OTS	3M	VHB 4657F	
1	Tape, electrical, 3/4" WD	IN	OTS	3M	Super 33+	
1	Label, IONX logo, for WSN101, 1"x2"	EA	MTS	any		
30	Potting material	GR	OTS	Sparta Polymers	HT1201	
1	Epoxy, thermal	ML	OTS	Resin Technology Group	KONA 870 FTLV-DP	

See Exhibit 2092 at 1, dated December 3, 2009; Exhibit 2168 (corroborating date).

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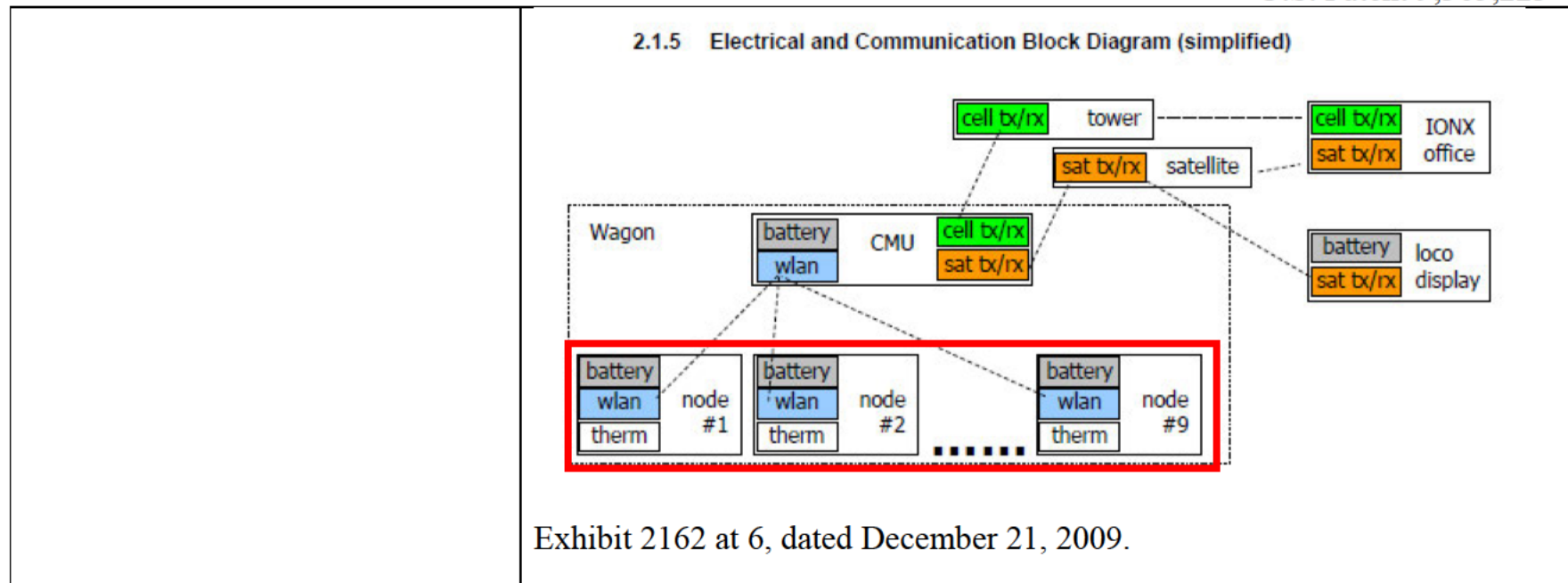
See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).

2.1.1 Wireless Sensor Node (WSN) (on Bearing Adapter)

- Type: Integrated temperature sensor
- Model: WSN101 (see Figure 1)
- Quantity: 9 per wagon x 10 wagons = 90 total
- Dimensions: 40mm x 88mm x 34mm
- Power source: self-contained high-performance battery (2-5 year life expectancy)
- Mounting method: thermally conductive epoxy adhesive and mechanical fastener
- Mounting locations:
 - Bearing temperature nodes: One on each bearing adapter, aligned with the wagon longitudinal axis on the inboard surface. Eight nodes per wagon. See red location indicator in Figure 2.
 - Ambient temperature node: One on the undercarriage of the wagon subjected to airflow, likely the underside of the sill. Exact location determined upon wagon inspection. One node per wagon.

Exhibit 2162 at 4, dated December 21, 2009.

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20. The system of claim 5 wherein said alarm is determined using distributed event processing based on a comparison between current data and statistical models of behavior.	“Stage 1: Bearing Trending -Alarm to IONX only. -Will be removed from locomotive display terminals - Will be used for trending recommendations and repeat offender identifications Stage 2: “Axle Differential Alarm” -Action: Stop train, check journal of alarmed bearing. Look for signs the bearing is “walking off” the axle or grease is being purged. -Proceed at reduced speed of 60 kph maximum until stage 2 alarm clear message is received at locomotive terminal -If stage 2 alarm clear message is received at the locomotive terminal, proceed as normal Stage 3: “Above Ambient Alarm” -Action: Stop train, check journal of alarming bearing. Look for signs the bearing is “walking off” the axle or grease is being purged -Proceed at reduced speed of 30 kph maximum until stage 3 alarm clear message is received at the locomotive terminal at which point speed can be increased to 60 kph.
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	-If the alarm message does not clear, a choice can be made to remove and change the bearing at an appropriate stoppage point, otherwise reduced speeds are required to reduce the chance of a screwed journal. -If Stage 2 and Stage 3 alarm clear messages are both received at the locomotive terminal, proceed as normal Stage 4: “Bearing Temp Alarm” -Action: Stop train, remove bearing.” See Exhibit 2020, dated April 4, 2010; Slide 8.
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21. The system of claim 5 wherein said alarms are determined based on a comparison of currently collected data versus data collected over a pre-determined preceding time period.	“Stage 1: Bearing Trending -Alarm to IONX only. -Will be removed from locomotive display terminals - Will be used for trending recommendations and repeat offender identifications Stage 2: “Axle Differential Alarm” -Action: Stop train, check journal of alarmed bearing. Look for signs the bearing is “walking off” the axle or grease is being purged. -Proceed at reduced speed of 60 kph maximum until stage 2 alarm clear message is received at locomotive terminal -If stage 2 alarm clear message is received at the locomotive terminal, proceed as normal Stage 3: “Above Ambient Alarm” -Action: Stop train, check journal of alarming bearing. Look for signs the bearing is “walking off” the axle or grease is being purged -Proceed at reduced speed of 30 kph maximum until stage 3 alarm clear message is received at the locomotive terminal at which point speed can be increased to 60 kph.
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	-If the alarm message does not clear, a choice can be made to remove and change the bearing at an appropriate stoppage point, otherwise reduced speeds are required to reduce the chance of a screwed journal. -If Stage 2 and Stage 3 alarm clear messages are both received at the locomotive terminal, proceed as normal Stage 4: “Bearing Temp Alarm” -Action: Stop train, remove bearing.” See Exhibit 2020, dated April 4, 2010; Slide 8.
22. The system of claim 5 wherein an alarm is raised based one or more of the following criteria:	

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- a. a pre-determined percentage of current data readings exceeds allowable peak readings;
- b. a pre-determined percentage of current data readings exceeds a determined value;
- c. a pre-determined percentage of current data readings exceeds a standard deviation from readings from the same railcar;
- d. a pre-determined percentage of current data readings exceeds a standard deviation from all railcars in the fleet; or
- e. the rate of change of current data readings exceeds a pre-determined threshold.

Peak Analysis

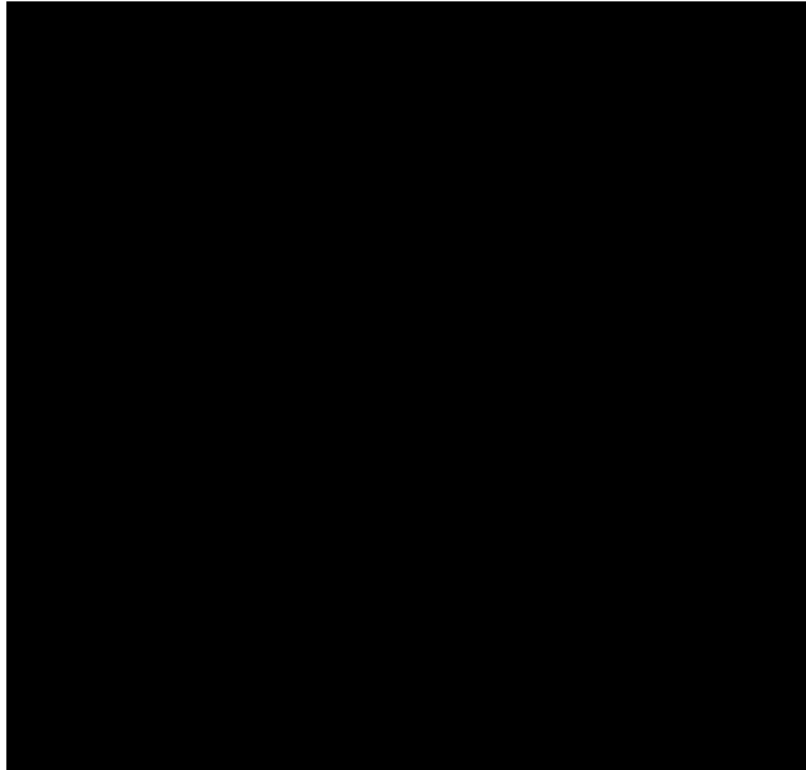
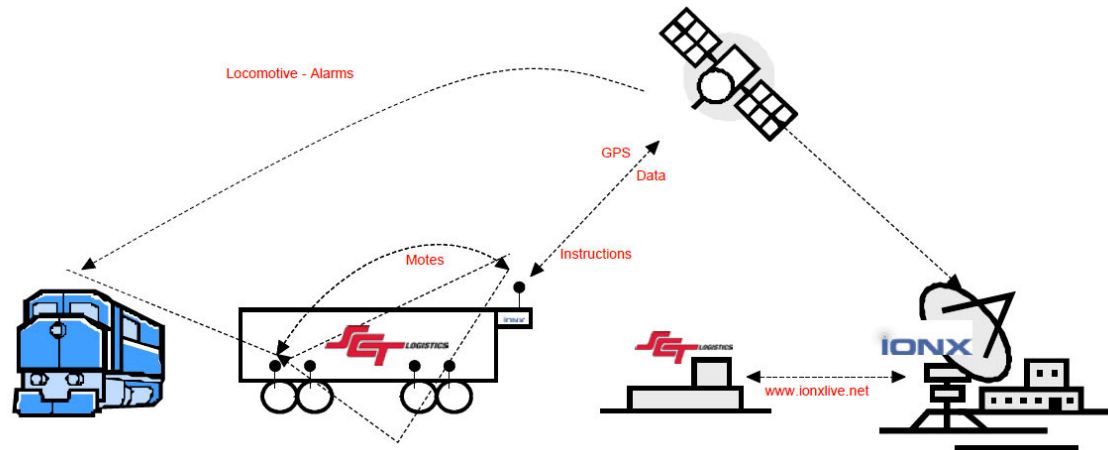


Exhibit 2060 at 2, dated May 4, 2010.

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23. A monitoring device for monitoring temperature on a railcar, comprising:



See Exhibit 2020, dated April 4, 2010; Slide 2.

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a housing mountable on a railcar;
a temperature sensor configured to be in thermal communication with a portion of the railcar to be monitored for temperature, which portion is external to said housing;

electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing;

a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing; and

a communication device capable of broadcasting information regarding the temperature sensed, said communication device positioned within said housing;



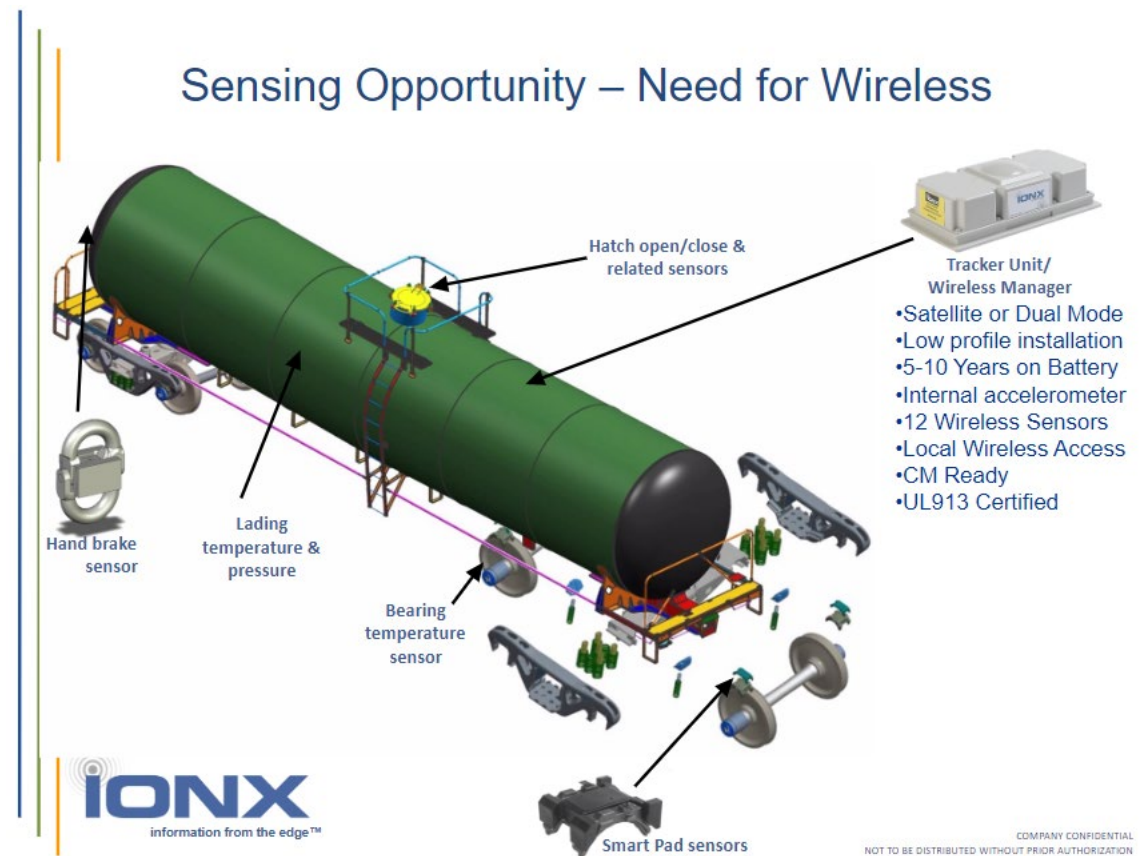
“4 bolt attached sensor (for smaller bearing end caps)”



“2 bolt attached sensor (for larger bearing end caps)”

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See Exhibit 2020, dated April 4, 2010; Slide 3.



See Exhibit 2017, dated 2010-03-21; slide 8; 2018 (metadata corroborating date)

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1) Components you will need:						
QTY	DESCRIPTION	UNIT		VENDOR	Vendor Part #	REV
1	PCBA, WSN-102	EA	MTS	SMT		8
1	Enclosure, WSN-1xx, Lid	EA	MTS	Protomold	063009WSNEL101-10	10
1	Enclosure, WSN-1xx, Base	EA	MTS	Protomold	063009WSNEB101-10	10
1	Brass Plug	EA	MTS	Hillside	062509WSNEP101-01	1
1	Battery pack, 2AA	EA	MTS	AVEX Electronics	AV-3398BP	
2	Wire, 26AWG, 7/24, PVC, white	IN	MTS	Alpha Wire	3049 WH005	
2	Wire, 26AWG, 7/24, PVC, red	IN	MTS	Alpha Wire	3049 RD005	
2	Wire, 26AWG, 7/24, PVC, black	IN	MTS	Alpha Wire	3049 BK005	
1	IC, temperature sensor, MCP9700A, TO-92	EA	OTS	Microchip	MCP9700A-E/TO	
1.5	Heat Shrink, 3/32"ID	IN	OTS	3M	VFP-876	
3	Double stick tape, 1" x 0.0625"	IN	OTS	3M	VHB 4657F	
1	Tape, electrical, 3/4" WD	IN	OTS	3M	Super 33+	
1	Label, IONX logo, for WSN101, 1"x2"	EA	MTS	any		
30	Potting material	GR	OTS	Sparta Polymers	HT1201	
1	Epoxy, thermal	ML	OTS	Resin Technology Group	KONA 870 FTLV-DP	

See Exhibit 2092 at 1, dated December 3, 2009; Exhibit 2168 (corroborating date).

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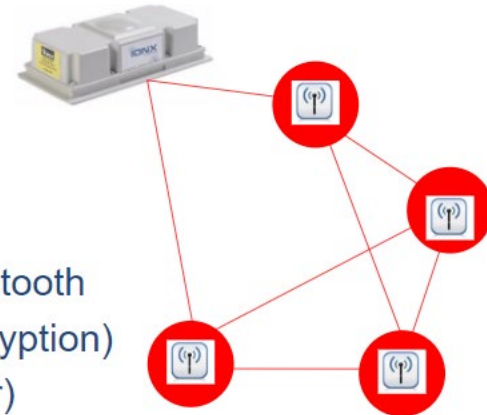


See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).

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Series 3 - Wireless car-based network

Radio off most of time
Redundant paths (mesh)
Scalable
Frequency Agile
Coexistence with Wi-Fi & Bluetooth
Secure (access control & encryption)
Intelligent routing (node power)



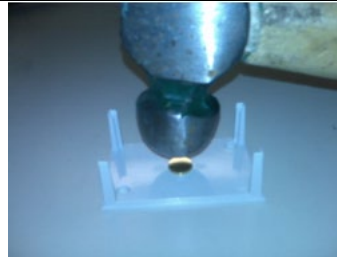
See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

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wherein the power consumption of said monitoring device is managed by placing said monitoring device in a standby state and periodically awakening said monitoring device to collect readings from said temperature sensor and to transmit the information regarding the temperature sensed via said communication circuitry.	“Power management: “wake/sleep” mode - The Edge asset monitoring system uses proprietary power management that minimizes the draw on the batteries. The communication management unit (CMU) has a defined message reporting schedule. When a message is scheduled to be generated and sent, the CMU powers on (wakes) to get location and other information from the sensors then transmits to the satellite. The CMU then powers off (sleeps) until its next scheduled power-on or wake-up period.” See June 2, 2010 email from Andrew Martin to Constantine Tarawneh and Brent Wilson, attaching Glossary of Terms dated September 18, 2008. Exhibits 2047, 2090 (metadata corroborating date)
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24. The monitoring device of claim 23 wherein at least a section of said temperature sensor is disposed outside of and spaced from said housing to be capable of contacting the surface of the railcar for which the temperature is to be monitored.



See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).

See Exhibit 2020, dated April 4, 2010; Slide 2.

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“4 bolt attached sensor (for smaller bearing end caps)”



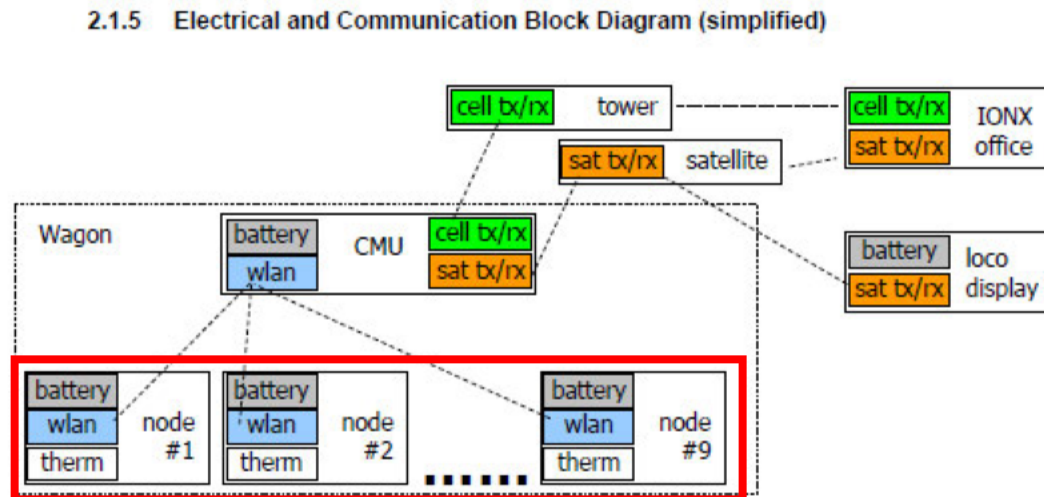
“2 bolt attached sensor (for larger bearing end caps)”

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	See Exhibit 2020, dated April 4, 2010; Slide 3.
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25. The monitoring device of claim 23 wherein said circuitry is configured to apply heuristics to analyze data collected from said temperature sensor to determine if a problem exists.



See Exhibit 2162 at 6, dated December 21, 2009.

Stage 1: Bearing Trending

- Alarm to IONX only.
- Will be removed from locomotive display terminals
- Will be used for trending recommendations and repeat offender identifications

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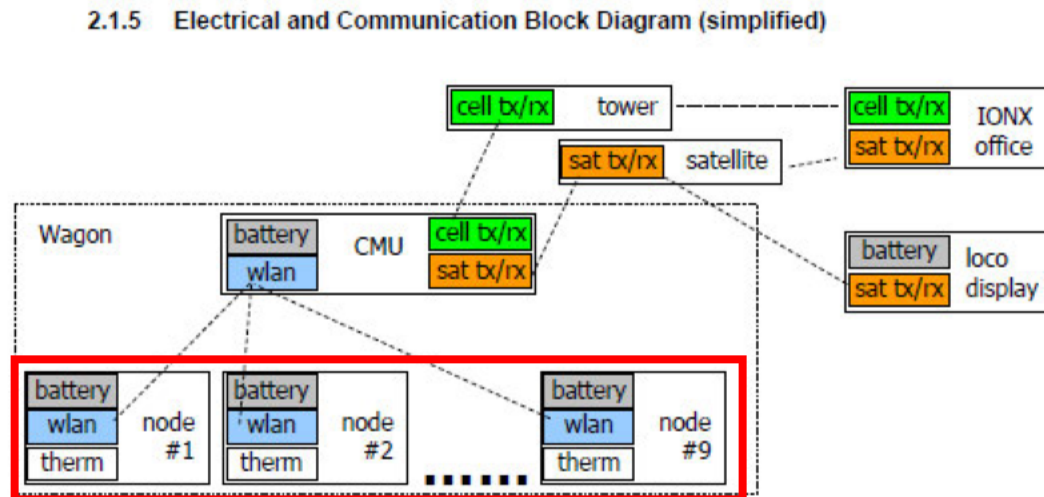
	Stage 2: “Axle Differential Alarm” -Action: Stop train, check journal of alarmed bearing. Look for signs the bearing is “walking off” the axle or grease is being purged. -Proceed at reduced speed of 60 kph maximum until stage 2 alarm clear message is received at locomotive terminal -If stage 2 alarm clear message is received at the locomotive terminal, proceed as normal Stage 3: “Above Ambient Alarm” -Action: Stop train, check journal of alarming bearing. Look for signs the bearing is “walking off” the axle or grease is being purged -Proceed at reduced speed of 30 kph maximum until stage 3 alarm clear message is received at the locomotive terminal at which point speed can be increased to 60 kph. -If the alarm message does not clear, a choice can be made to remove and change the bearing at an appropriate stoppage point, otherwise reduced speeds are required to reduce the chance of a screwed journal. -If Stage 2 and Stage 3 alarm clear messages are both received at the locomotive terminal, proceed as normal Stage 4: “Bearing Temp Alarm”
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	-Action: Stop train, remove bearing.” See Exhibit 2020, dated April 4, 2010; Slide 8. “Phase one algorithm for bearing condition assessment will be run for three months then analyzed for refinement. The algorithm has been incorporated into the IONX software and is currently being bench tested in West Chester.” See Exhibit 2165, dated February 2, 2010; Slide 2.
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26. The system of claim 2 wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor devices (a) to determine if an actual failure exists and (b) to predict potential or imminent failures based on a statistical analysis of said collected data.



See Exhibit 2162 at 6, dated December 21, 2009.

Stage 1: Bearing Trending

- Alarm to IONX only.
- Will be removed from locomotive display terminals
- Will be used for trending recommendations and repeat offender identifications

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	Stage 2: “Axle Differential Alarm” -Action: Stop train, check journal of alarmed bearing. Look for signs the bearing is “walking off” the axle or grease is being purged. -Proceed at reduced speed of 60 kph maximum until stage 2 alarm clear message is received at locomotive terminal -If stage 2 alarm clear message is received at the locomotive terminal, proceed as normal Stage 3: “Above Ambient Alarm” -Action: Stop train, check journal of alarming bearing. Look for signs the bearing is “walking off” the axle or grease is being purged -Proceed at reduced speed of 30 kph maximum until stage 3 alarm clear message is received at the locomotive terminal at which point speed can be increased to 60 kph. -If the alarm message does not clear, a choice can be made to remove and change the bearing at an appropriate stoppage point, otherwise reduced speeds are required to reduce the chance of a screwed journal. -If Stage 2 and Stage 3 alarm clear messages are both received at the locomotive terminal, proceed as normal Stage 4: “Bearing Temp Alarm”
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	-Action: Stop train, remove bearing.” See Exhibit 2020, dated April 4, 2010; Slide 8. “Phase one algorithm for bearing condition assessment will be run for three months then analyzed for refinement. The algorithm has been incorporated into the IONX software and is currently being bench tested in West Chester.” See Exhibit 2165, dated February 2, 2010; Slide 2.
27. The system of claim 2 further comprising a second temperature sensor located on said railcar for measuring ambient air temperature, wherein said system uses information obtained from said second temperature sensor about the ambient temperature to calibrate the temperature data received from said first sensor regarding the item of the railcar being monitored.	“Mounting locations: Bearing temperature nodes: One on each bearing adapter, aligned with the wagon longitudinal axis on the inboard surface. Eight nodes per wagon. See red location indicator in Figure 2. Ambient temperature node: One on the undercarriage of the wagon subjected to airflow, likely the underside of the sill. Exact location determined upon wagon inspection. One node per wagon.... Temperature readings and gradients will be flagged (ie, trigger an alert) based on the following criteria: Absolute temperature $\geq 200^{\circ}\text{F}$ 190°F above ambient temperature” See Exhibit 2162 at 2, 5, dated December 21, 2009.

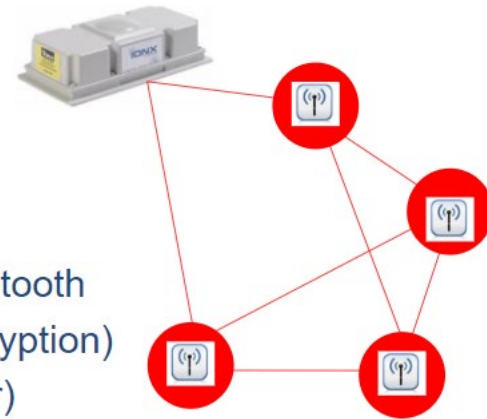
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28. The system of claim 2 wherein said communicating management unit is capable of communicating data and alarms to a remote location located off of the train of which the railcar is a part.

See Exhibit 2020, dated April 4, 2010; Slide 2.

Series 3 - Wireless car-based network

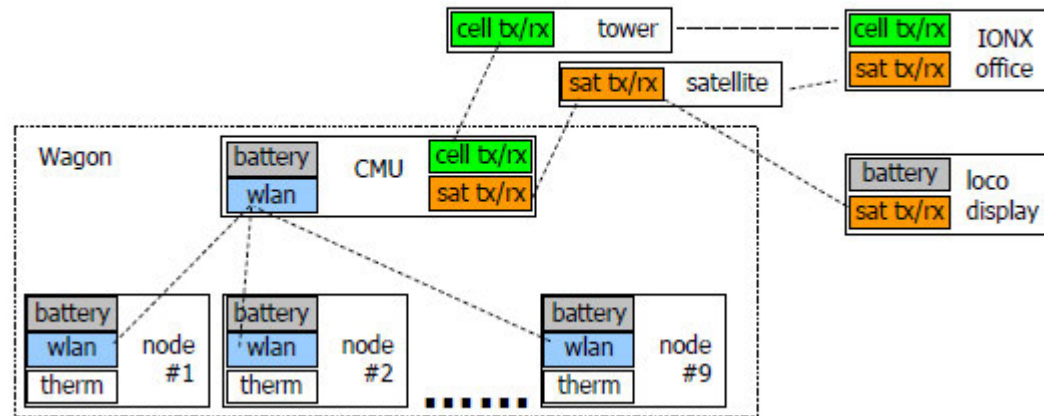
Radio off most of time
Redundant paths (mesh)
Scalable
Frequency Agile
Coexistence with Wi-Fi & Bluetooth
Secure (access control & encryption)
Intelligent routing (node power)



See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

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2.1.5 Electrical and Communication Block Diagram (simplified)



See Exhibit 2162 at 6, dated December 21, 2009.

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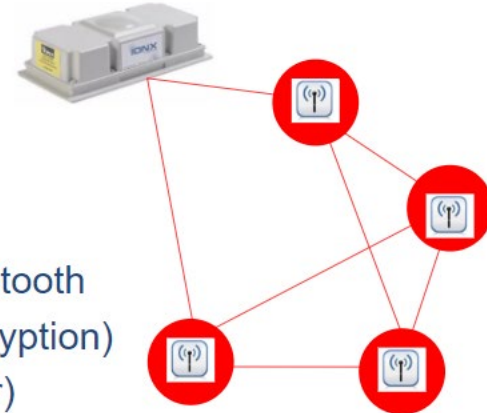
29. The system of claim 2 wherein the power consumption of each of said sensor devices is managed by placing each said sensor device in a standby state and periodically awakening said sensor device to collect readings from said sensor device and to transmit the information regarding the parameter or condition being sensed via said communication circuitry.	“Power management: “wake/sleep” mode - The Edge asset monitoring system uses proprietary power management that minimizes the draw on the batteries. The communication management unit (CMU) has a defined message reporting schedule. When a message is scheduled to be generated and sent, the CMU powers on (wakes) to get location and other information from the sensors then transmits to the satellite. The CMU then powers off (sleeps) until its next scheduled power-on or wake-up period.” See June 2, 2010 email from Andrew Martin to Constantine Tarawneh and Brent Wilson, attaching Glossary of Terms dated September 18, 2008. Exhibits 2047, 2090 (metadata corroborating date) “Report regular temperature readings from each node to ionxlive every 1 to 8 hours. The reporting frequency may be modified mid-test to facilitate network or power constraints.... Report alerts to ionxlive and locomotive display immediately, including wagon location and speed” See Exhibit 2162 at 5, dated December 21, 2009.
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30. The system of claim 2 wherein said communication management unit and said plurality of sensor devices form a wireless mesh network for said railcar.

Series 3 - Wireless car-based network

Radio off most of time
Redundant paths (mesh)
Scalable
Frequency Agile
Coexistence with Wi-Fi & Bluetooth
Secure (access control & encryption)
Intelligent routing (node power)



See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

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31. The system of claim 5 wherein the power consumption of each of said sensing units is managed by placing each sensing unit in a standby state and periodically awakening said sensing unit to collect readings from said sensor and to transmit information via said communications circuitry.	“Power management: “wake/sleep” mode - The Edge asset monitoring system uses proprietary power management that minimizes the draw on the batteries. The communication management unit (CMU) has a defined message reporting schedule. When a message is scheduled to be generated and sent, the CMU powers on (wakes) to get location and other information from the sensors then transmits to the satellite. The CMU then powers off (sleeps) until its next scheduled power-on or wake-up period.” See June 2, 2010 email from Andrew Martin to Constantine Tarawneh and Brent Wilson, attaching Glossary of Terms dated September 18, 2008. Exhibits 2047, 2090 (metadata corroborating date)
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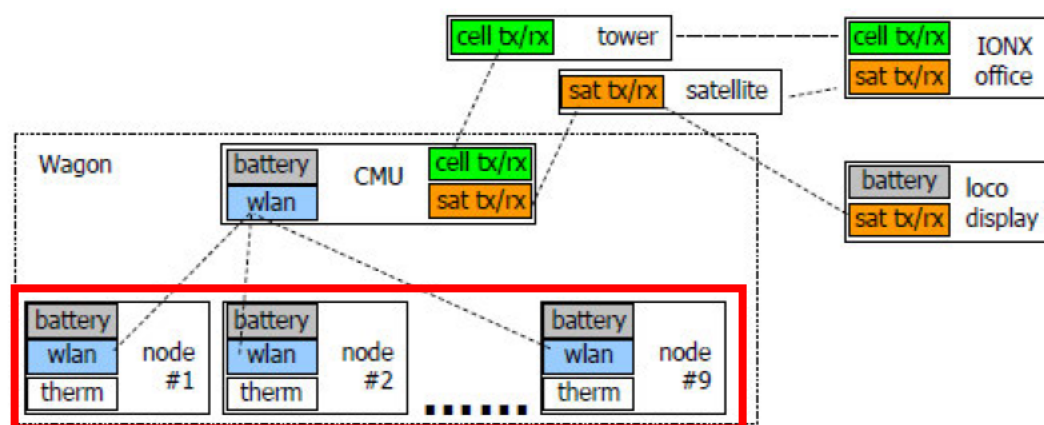
32. The system of claim 5 wherein said communication management unit is capable of communicating with a remote location located off of a train of which said railcar is a part.

2.1.1 Wireless Sensor Node (WSN) (on Bearing Adapter)

- Type: Integrated temperature sensor
- Model: WSN101 (see Figure 1)
- Quantity: 9 per wagon x 10 wagons = 90 total
- Dimensions: 40mm x 88mm x 34mm
- Power source: self-contained high-performance battery (2-5 year life expectancy)
- Mounting method: thermally conductive epoxy adhesive and mechanical fastener
- Mounting locations:
 - Bearing temperature nodes: One on each bearing adapter, aligned with the wagon longitudinal axis on the inboard surface. Eight nodes per wagon. See red location indicator in Figure 2.
 - Ambient temperature node: One on the undercarriage of the wagon subjected to airflow, likely the underside of the sill. Exact location determined upon wagon inspection. One node per wagon.

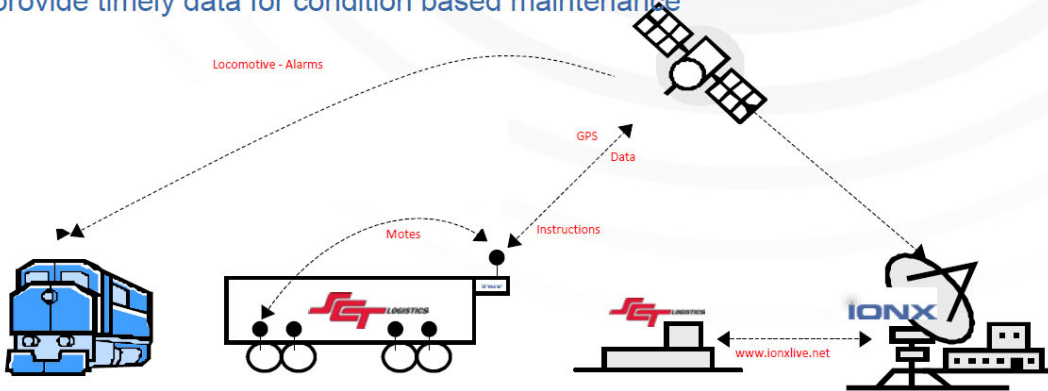
Exhibit 2162 at 4, dated December 21, 2009.

2.1.5 Electrical and Communication Block Diagram (simplified)



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	Exhibit 2162 at 6, dated December 21, 2009.
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U.S. Patent No. 9,365,223	Reduction to Practice
2. A system for monitoring a railcar, comprising:	“IONX has developed and proven a bearing condition monitoring system with action instructions for any critical alerts” See Exhibit 2154, dated August 2, 2011; Slide 13. Objectives: Pilot Project <i>Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet</i> •Monitor bearing temperatures on ten wagons – validate technology •Create actionable alarms for “hot” bearings – including locomotive alert system •Collect data to validate algorithms that indicate bearing “condition” •To provide timely data for condition based maintenance  See Exhibit 2154, dated August 2, 2011; Slide 3.

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a plurality of sensor devices located on the railcar for monitoring parameters or conditions of the railcar, each of said sensor devices being separate from one another and including a sensor for monitoring one of said parameters or conditions of the railcar;



See Exhibit 2154, dated August 2, 2011; Slide 6.

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said plurality of sensor devices including at least one temperature sensor device having: a housing; a temperature sensor in thermal communication with an item of the railcar for which the temperature is being monitored, which item is external to said housing; electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing; a power source electrically connected to said electrical circuitry	See Exhibit 2092 at 1, dated December 3, 2009; Exhibit 2168 (corroborating date).  “Fill top and bottom side of PCB board inside hole” See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).
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for providing power thereto, said power source positioned within said housing;

a communication device capable of broadcasting information regarding the temperature sensed via wireless communication, said communication device positioned within said housing; and



“4 bolt attached sensor (for smaller bearing end caps)”



“2 bolt attached sensor (for larger bearing end caps)”

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See Exhibit 2020, dated April 4, 2010; Slide 3.



Freight car install:
(1)Dual Mode Sat/Cell wireless CMU-351
(2)9 WSN-102 wireless temperature sensors per car

See Exhibit 2022, dated April 8, 2010; Slide 5.

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	“Procedure 1) Power on WSNs and CMU 2) Connect CMU to PC using hyperterminal or IONXComm 3) With test units in close proximity to one another, wait for all nodes to join network and go live. In addition to serial data following each event, this can be confirmed using “get network” and “000200” instructions. 4) Place WSNs and CMU in planned mounting locations 5) Wait at least 30 minutes for network to stabilize 6) Take network path measurements: a. Use “get path stats” to determine first path strength b. Record path stability and RSSI (relative signal strength indicator). A path between the CMU and a node will have RSSI listed for only one direction. For node-to-node paths an RSSI will be returned for both directions. Record the lower (ie, most negative) value only c. Repeat “get path stats” for each subsequent path, recording data, until end of list is reached (notification displayed on screen)” See Exhibit 2164, dated 2010-01-15.
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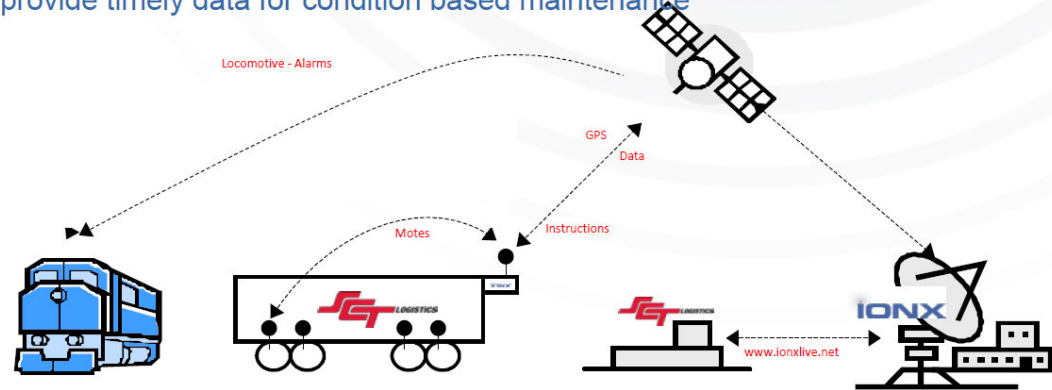
Declaration of Michael I. Shamos
U.S. Patent 9,365,223

a communication management unit, mounted on the railcar, capable of two way wireless communication with each of said plurality of sensor devices for receiving information therefrom, said communication management unit having a wireless communication device for broadcasting information about the parameter or condition being monitored.

Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

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See Exhibit 2154, dated August 2, 2011; Slide 6.

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Freight car install:
(1)Dual Mode Sat/Cell wireless CMU-351
(2)9 WSN-102 wireless temperature sensors per car

See Exhibit 2022, dated April 8, 2010; Slide 5.

“Procedure

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	1) Power on WSNs and CMU 2) Connect CMU to PC using hyperterminal or IONXComm 3) With test units in close proximity to one another, wait for all nodes to join network and go live. In addition to serial data following each event, this can be confirmed using “get network” and “000200” instructions. 4) Place WSNs and CMU in planned mounting locations 5) Wait at least 30 minutes for network to stabilize 6) Take network path measurements: a. Use “get path stats” to determine first path strength b. Record path stability and RSSI (relative signal strength indicator). A path between the CMU and a node will have RSSI listed for only one direction. For node-to-node paths an RSSI will be returned for both directions. Record the lower (ie, most negative) value only c. Repeat “get path stats” for each subsequent path, recording data, until end of list is reached (notification displayed on screen)” See Exhibit 2164, dated 2010-01-15.
3. The system of claim 2 wherein said communication management unit can make a determination of an alarm condition based on data collected by two	“IONX has developed condition based metrics to assess performance before a bearing is a burn-off risk IONX has identified other components (such as bogies) that effect bearing performance, and can now identify when those components are the cause” See Exhibit 2154, dated August 2, 2011; Slide 13.

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or more of said sensor devices.	“March 28, 2010, Brent Wilson emailed the Amsted team that the SCT trial had begun, and that bearing temperatures would be monitored and subsequently analyzed to make the algorithms more robust.” See Exhibit 2041. Email string including the team of non-inventors and inventors discussing changing the parameter in the algorithm with the values sent from Brent and Andrew and updating the WSNs in the field. See Exhibits 2013 at ¶18, 2031, 2033.
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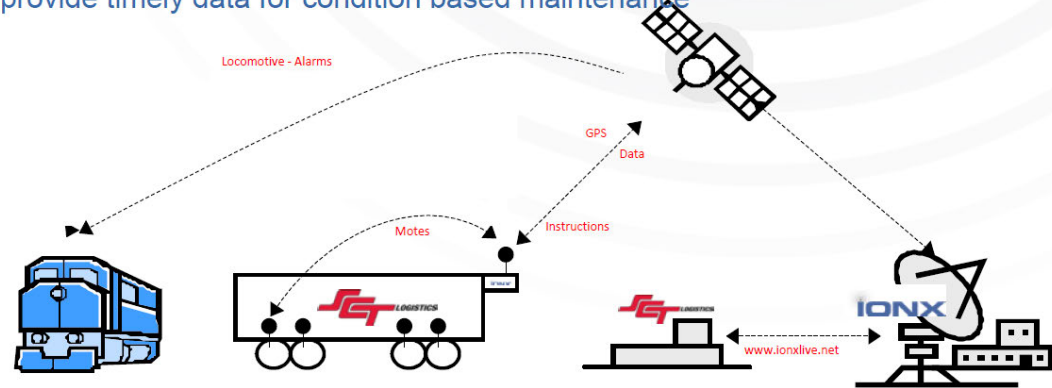
Declaration of Michael I. Shamos
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4. The system of claim 2 wherein each of said plurality of sensor devices is capable of exchanging data with other of said plurality of sensor devices and with said communication management unit.

Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

5. A system for monitoring the operation of a railcar comprising:

“IONX has developed and proven a bearing condition monitoring system with action instructions for any critical alerts”

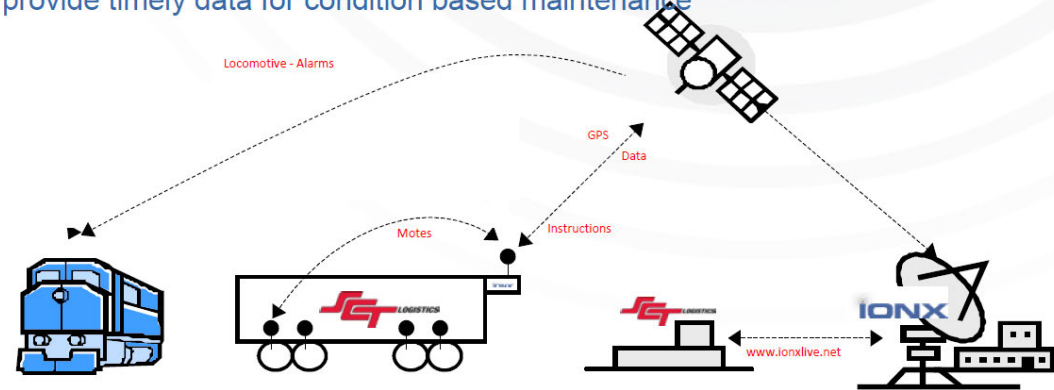
See Exhibit 2154, dated August 2, 2011; Slide 13.

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Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

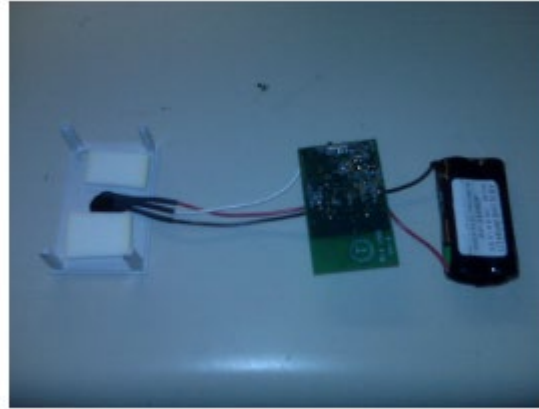
- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

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a. one or more sensor units mounted on said railcar, each of said sensor units monitoring an operating parameter of said railcar wherein each of said sensor units comprises a sensor, a power source, a processor, memory, communications circuitry, and software, stored in said memory and executed by said processor, said software performing the functions of collecting data from said sensor at periodic intervals; and



See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).

“Progress and Milestones

- Installed on ten wagons with more than sixteen months of service
- Over 18 million temperature readings collected to date
- Over 8.5 million kilometers of freight mileage monitored”



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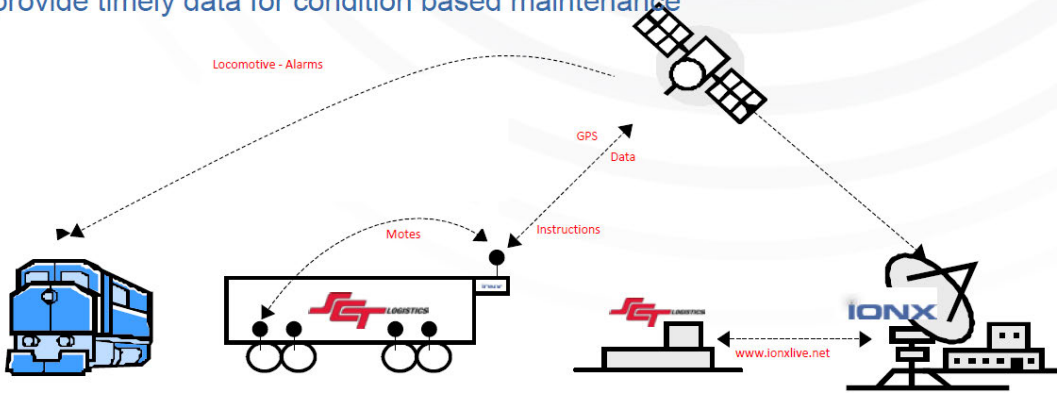


See Exhibit 2154, dated August 2, 2011; Slide 4.

IONX Node Sampling Rate

- The current data set from the SCT field test is sampled every minute.
- In order to reduce processor and communication bandwidth, the sampling rate of the IONX nodes must be minimized
- The existing data set will be re-sampled at 2, 4, and 8 minute intervals and Level 3 Statistics will be recalculated in order to determine if there is a loss of accuracy

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	Exhibit 2146, dated June 22, 2011, Slide 8
b. a communication management unit, mounted on said railcar, said communication management unit in wireless communication with said one or more sensor units;	Objectives: Pilot Project <i>Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet</i> • Monitor bearing temperatures on ten wagons – validate technology • Create actionable alarms for “hot” bearings – including locomotive alert system • Collect data to validate algorithms that indicate bearing “condition” • To provide timely data for condition based maintenance  See Exhibit 2154, dated August 2, 2011; Slide 3.

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Freight car install:
(1)Dual Mode Sat/Cell wireless CMU-351
(2)9 WSN-102 wireless temperature sensors per car

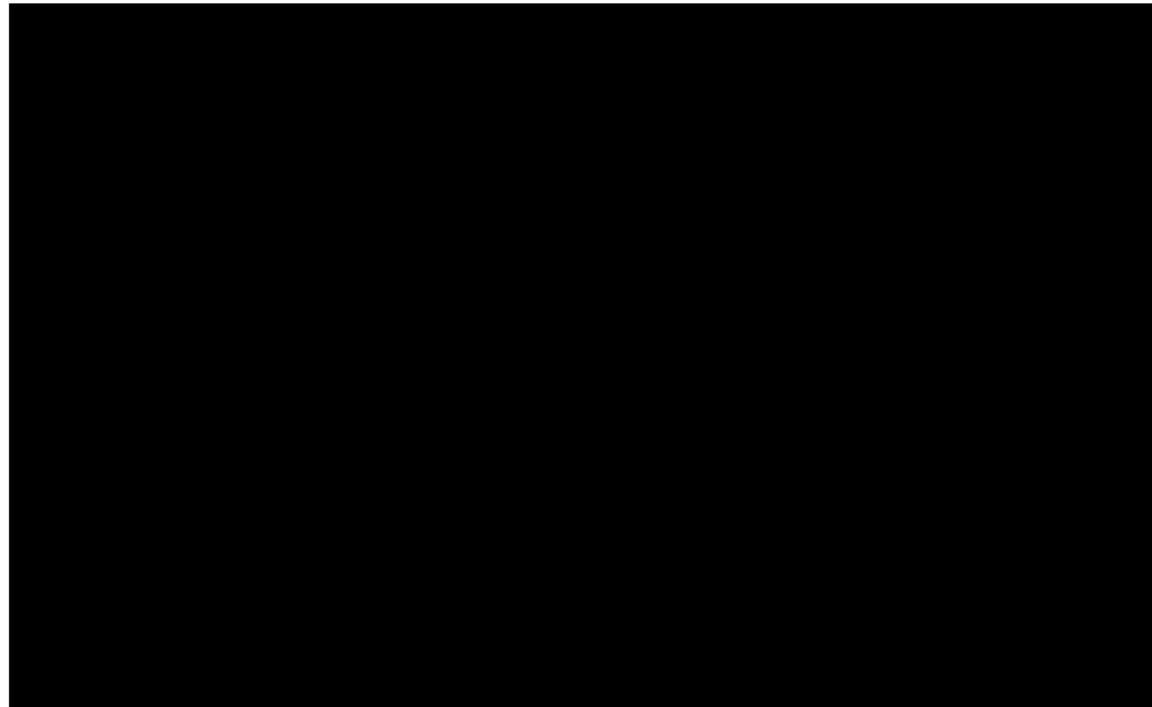
See Exhibit 2022, dated April 8, 2010; Slides 3,5

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wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor units (a) to determine if an actual failure exists and (b) to predict potential or imminent failures based on a statistical analysis of said collected data.	“IONX has developed condition based metrics to assess performance before a bearing is a burn-off risk IONX has identified other components (such as bogies) that effect bearing performance, and can now identify when those components are the cause” See Exhibit 2154, dated August 2, 2011; Slide 13. “March 28, 2010, Brent Wilson emailed the Amsted team that the SCT trial had begun, and that bearing temperatures would be monitored and subsequently analyzed to make the algorithms more robust.” See Exhibit 2041.
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Alert Instructions



See Exhibit 2022, dated April 8, 2010; Slide 10

“Create actionable alarms for “hot” bearings – including locomotive alert system”

See Exhibit 2154, dated August 2, 2011; Slide 3.

“Actionable alarms for “hot” bearings

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	- Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest. - Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5.
6. The system of claim 5 wherein said determination of an alarm condition can be made by one of said sensor units.	"Actionable alarms for "hot" bearings - Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest. - Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5.
7. The system of claim 5 wherein said determination of an alarm condition can be	"Actionable alarms for "hot" bearings

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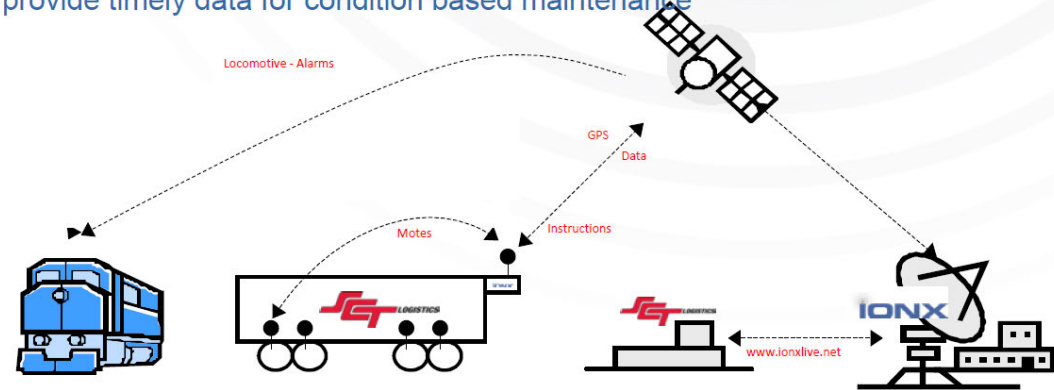
made by said communication management unit based on data collected by two or more of said sensor units.	- Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest. - Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5.
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Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

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8. The system of claim 5 wherein each of said sensor units comprises:

- a. a sensor;
- b. a power source;
- c. a processor;
- d. memory;
- e. communications circuitry; and
- f. software, stored in said memory and executed by said processor, said software performing the functions of collecting data from said sensor at periodic intervals.



See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).

“Progress and Milestones

- Installed on ten wagons with more than sixteen months of service
- Over 18 million temperature readings collected to date
- Over 8.5 million kilometers of freight mileage monitored”



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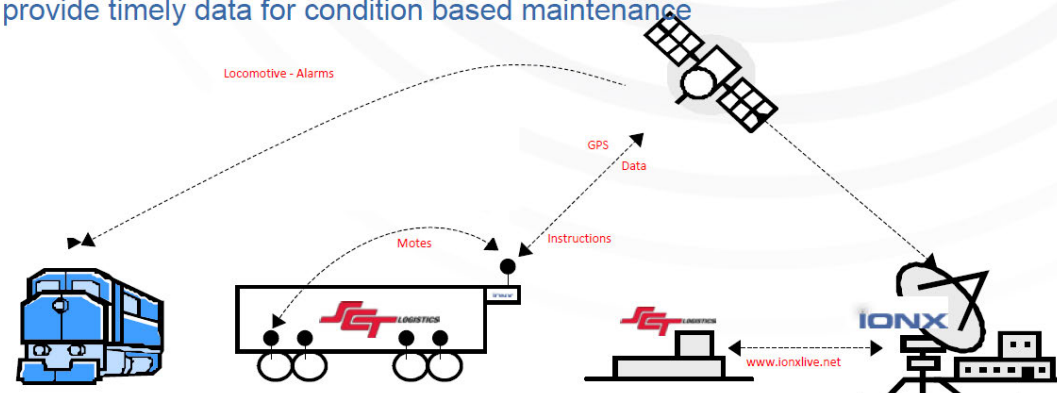


See Exhibit 2154, dated August 2, 2011; Slide 4.

IONX Node Sampling Rate

- The current data set from the SCT field test is sampled every minute.
- In order to reduce processor and communication bandwidth, the sampling rate of the IONX nodes must be minimized
- The existing data set will be re-sampled at 2, 4, and 8 minute intervals and Level 3 Statistics will be recalculated in order to determine if there is a loss of accuracy

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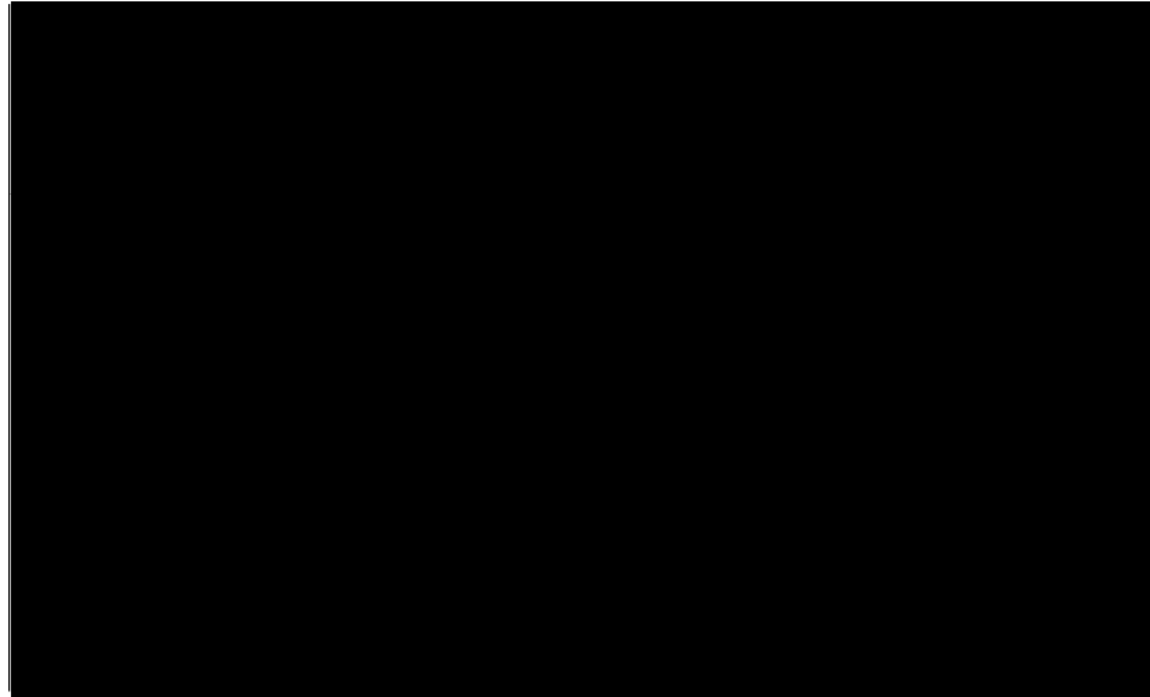
	Exhibit 2146, dated June 22, 2011, Slide 8
9. The system of claim 8 wherein said software further performs the function of:	
assessing the collected data to determine if an alarm condition exists; and communicating said alarm condition to said communication management unit via said communications circuitry; and managing the power consumption of said sensor unit by placing said sensor unit in a standby state and periodically awakening said sensor unit to collect data from said sensor and to transmit information	Objectives: Pilot Project <i>Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet</i> • Monitor bearing temperatures on ten wagons – validate technology • Create actionable alarms for “hot” bearings – including locomotive alert system • Collect data to validate algorithms that indicate bearing “condition” • To provide timely data for condition based maintenance  See Exhibit 2154, dated August 2, 2011; Slide 3.

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regarding said operating parameter to said communication management unit via said communication circuitry.	“Andoni has configured one WSN to report temperature readings every 15 seconds” See Exhibit 2151, dated July 19, 2011, at 19. “End of presentation has latest progress on pushing algorithms onto WSN. Conclusion is that majority can be done at WSN, and just two algorithms will need to send Temperature Average, Number of samples, and Standard Deviation every 6 hours to the CMU.” See Exhibit 2152.
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Alert Instructions



See Exhibit 2022, dated April 8, 2010; Slide 10

“Create actionable alarms for “hot” bearings – including locomotive alert system”

See Exhibit 2154, dated August 2, 2011; Slide 3.

“Actionable alarms for “hot” bearings

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	• Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest. • Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5. "Power management: "wake/sleep" mode - The Edge asset monitoring system uses proprietary power management that minimizes the draw on the batteries. The communication management unit (CMU) has a defined message reporting schedule. When a message is scheduled to be generated and sent, the CMU powers on (wakes) to get location and other information from the sensors then transmits to the satellite. The CMU then powers off (sleeps) until its next scheduled power-on or wake-up period." See June 2, 2010 email from Andrew Martin to Constantine Tarawneh and Brent Wilson, attaching Glossary of Terms dated September 18, 2008. Exhibits 2047, 2090 (metadata corroborating date)
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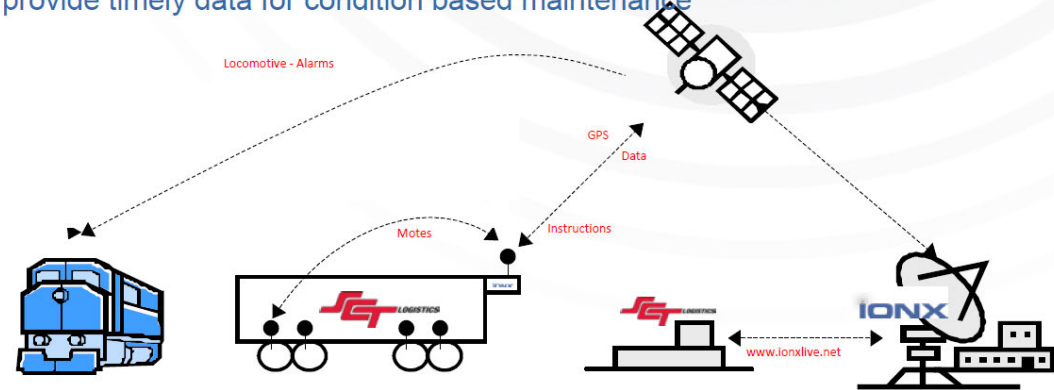
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10. The system of claim 5 wherein said one or more sensor units and said communication management unit are in wireless communication with each other and form a local area wireless network for said railcar.

Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

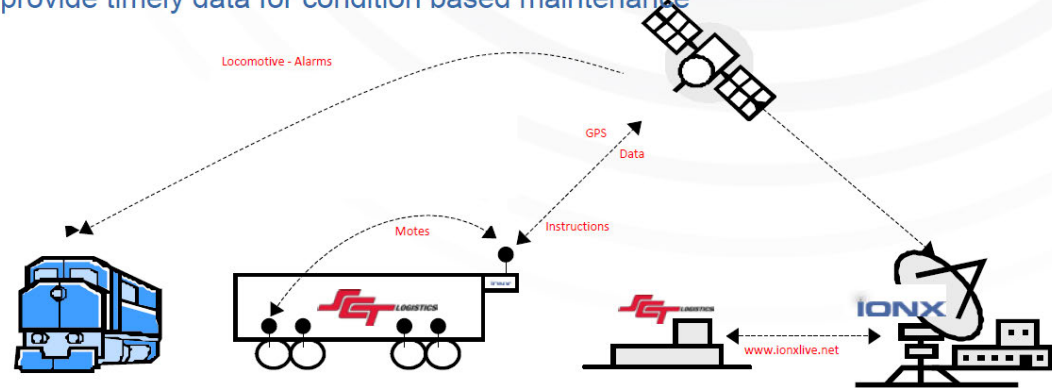
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13. The system of claim 5 further comprising a base unit, said base unit being in wireless communication with said communication management unit, said based unit performing the functions of:

Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance

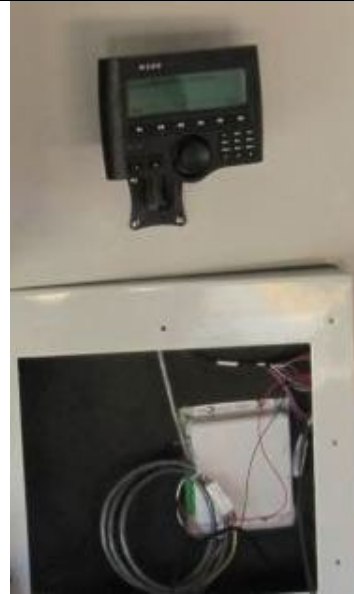


See Exhibit 2154, dated August 2, 2011; Slide 3.

“Actionable alarms for “hot” bearings

- Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest.

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See Exhibit 2154, dated August 2, 2011; Slide 5.

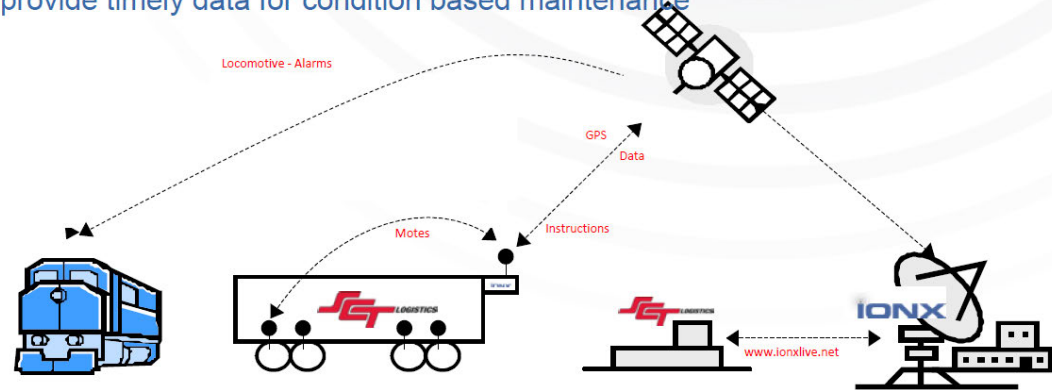
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a. collecting data and alarms from said communication management unit;

Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

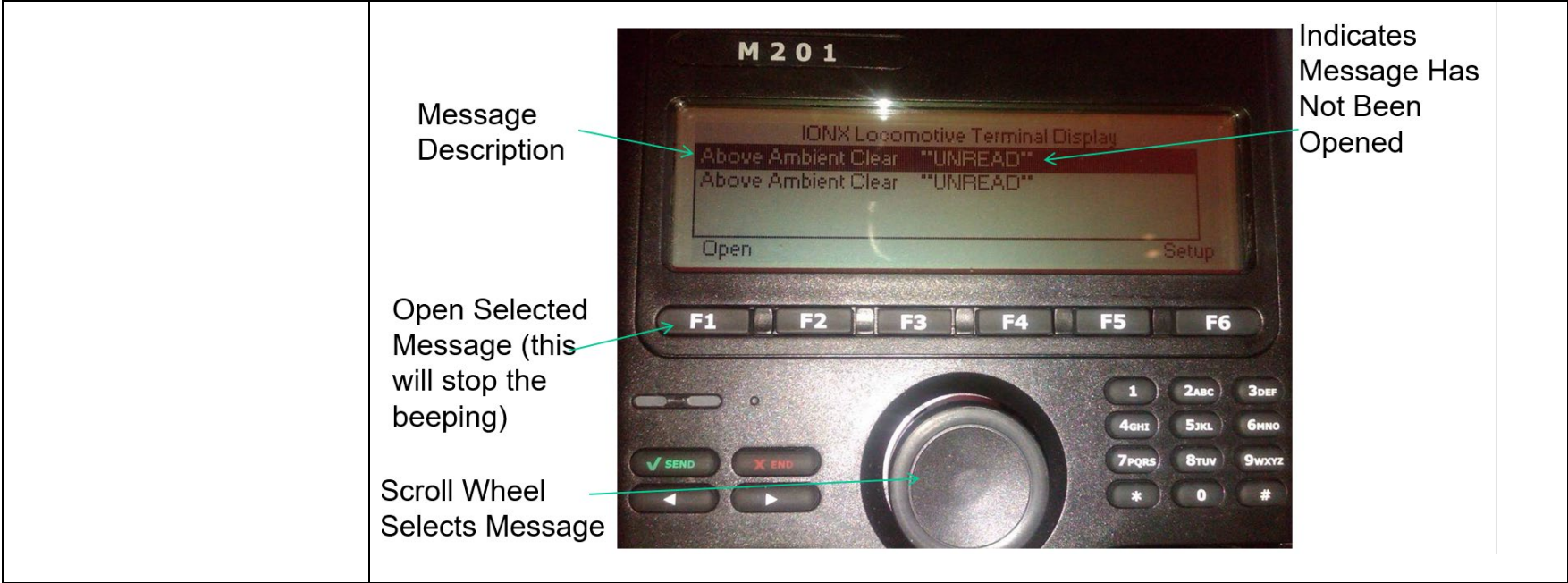
“Actionable alarms for “hot” bearings

- Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest.

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	Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5.
b. displaying alarm conditions raised by said communication management unit; and	 See Exhibit 2154, dated August 2, 2011; Slide 5.

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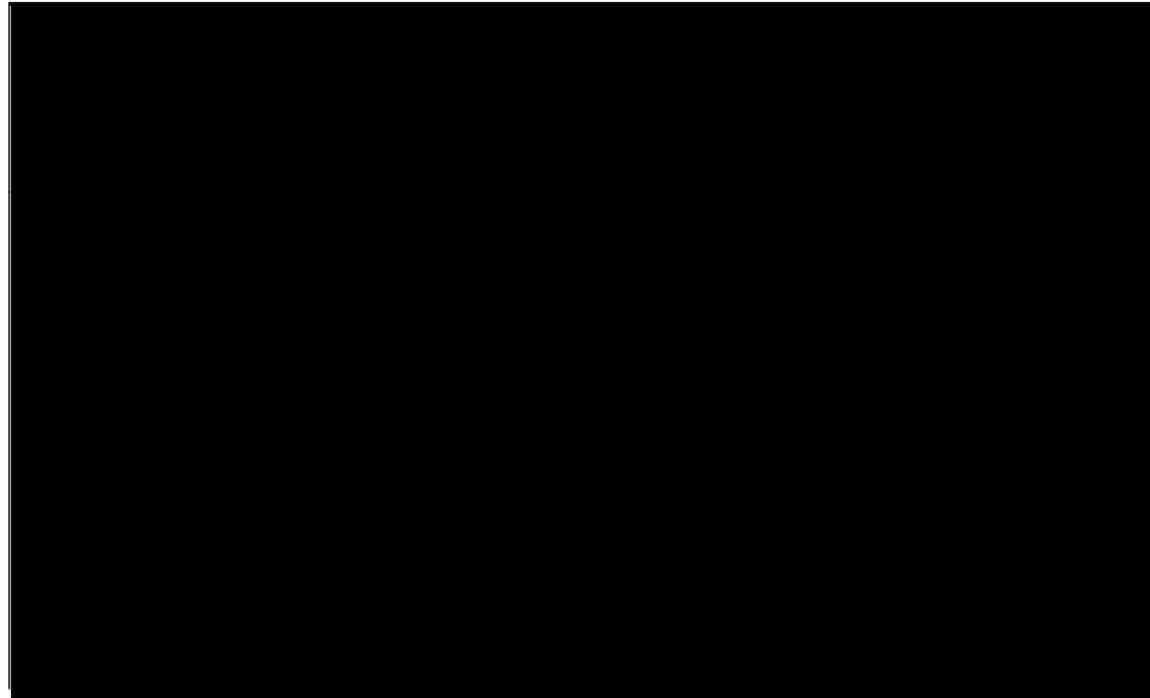
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	Car Name Affected Bearing or Axle Date and Time Received Return to Inbox  Alert Type Temperature of Bearing See Exhibit 2020, ¶¶71-72.
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c. determining high level alarms based on data and alarms collected from said communication management unit.

Alert Instructions



See Exhibit 2022, dated April 8, 2010; Slide 10

“Create actionable alarms for “hot” bearings – including locomotive alert system”

See Exhibit 2154, dated August 2, 2011; Slide 3.

“Actionable alarms for “hot” bearings

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	• Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest. • Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5.
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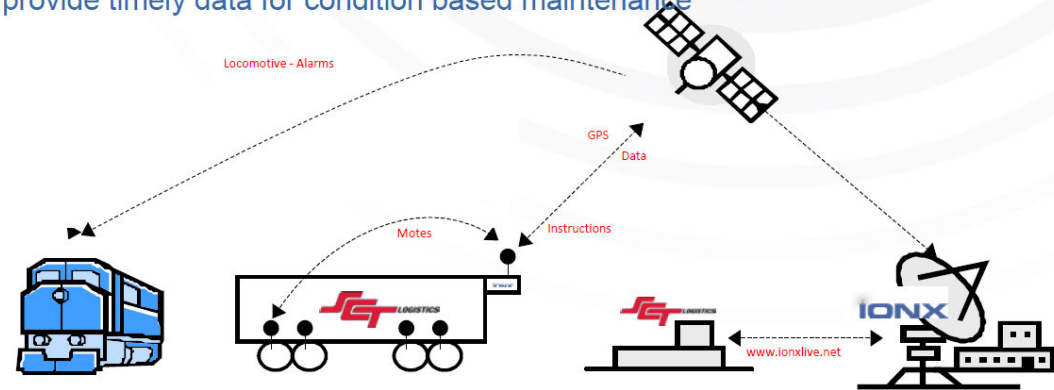
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14. The system of claim 13 wherein said base unit is in wireless communication with multiple communication management units.

Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

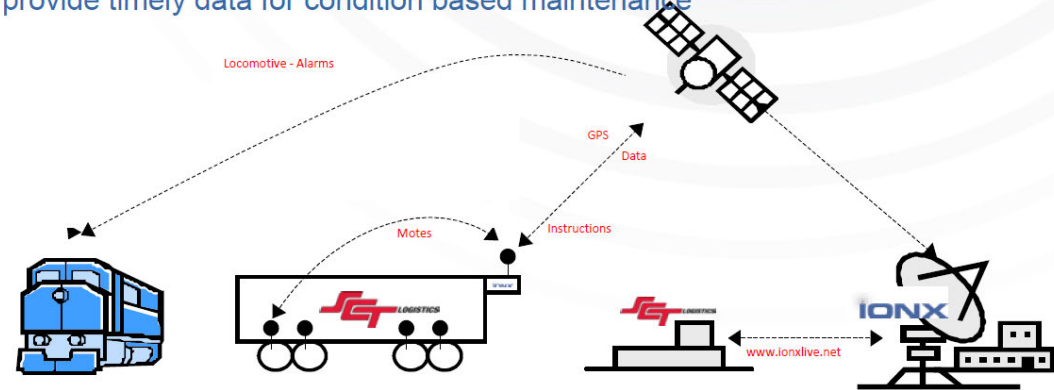
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15. The system of claim 14 wherein said base unit uses distributed event processing to perform trend analysis based on alarms and data collected from one or more communication management units to determine if a high level alarm should be raised.

Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

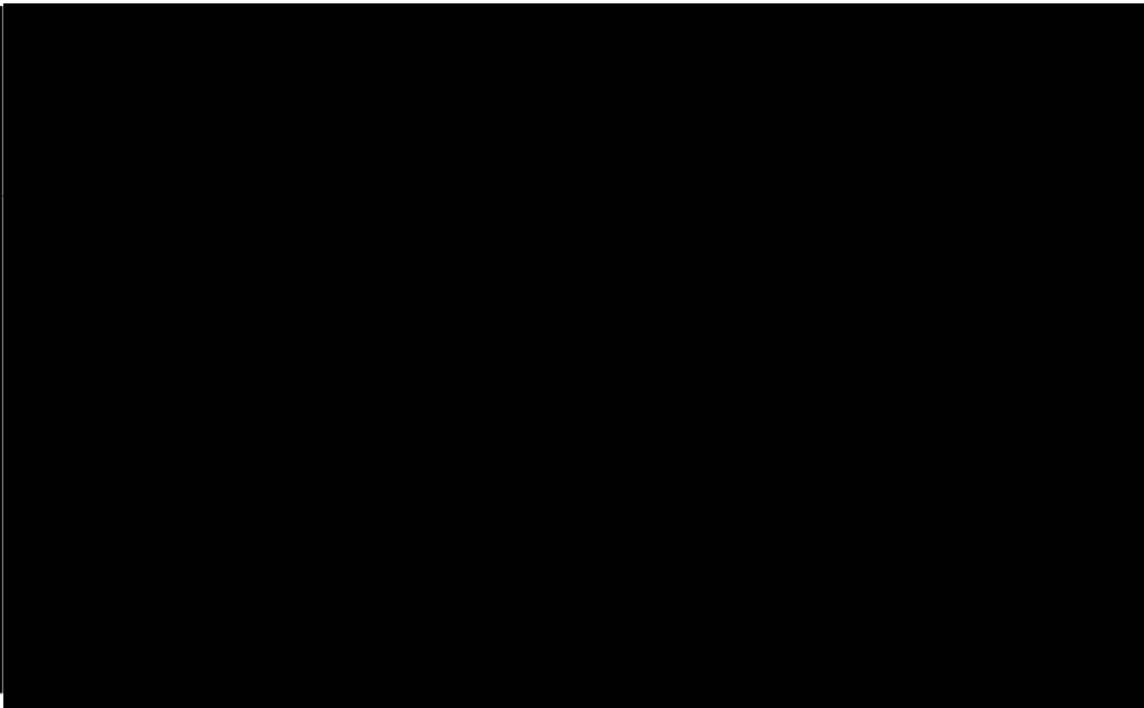
“Actionable alarms for “hot” bearings

- Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest.

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	• Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5. "End of presentation has latest progress on pushing algorithms onto WSN. Conclusion is that majority can be done at WSN, and just two algorithms will need to send Temperature Average, Number of samples, and Standard Deviation every 6 hours to the CMU." See Exhibit 2152.
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	Alert Instructions  See Exhibit 2022, dated April 8, 2010; Slide 10.
16. The system of claim 14 wherein said base unit applies heuristics to data collected from said one or more communication management units to	“March 28, 2010, Brent Wilson emailed the Amsted team that the SCT trial had begun, and that bearing temperatures would be monitored and subsequently analyzed to make the algorithms more robust.” See Exhibit 2041.

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determine if a high level alarm should be raised.	“Objectives: Pilot Project <i>Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet</i> • Monitor bearing temperatures on ten wagons – validate technology • Create actionable alarms for “hot” bearings – including locomotive alert system • Collect data to validate algorithms that indicate bearing “condition” • To provide timely data for condition based maintenance” See Exhibit 2154, dated August 2, 2011; Slide 3.
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	ALGORITHM OVERVIEW  and entire IONX Bearing Health Monitoring Algorithm Slide Presentation See Exhibit 2067, dated 6/22/2010.
17. The system of claim 16 wherein said base unit	“Actionable alarms for “hot” bearings

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and said one or more communication management units communicate with each other via a satellite communications capability or a cellular network capability.	• Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest. • Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5.
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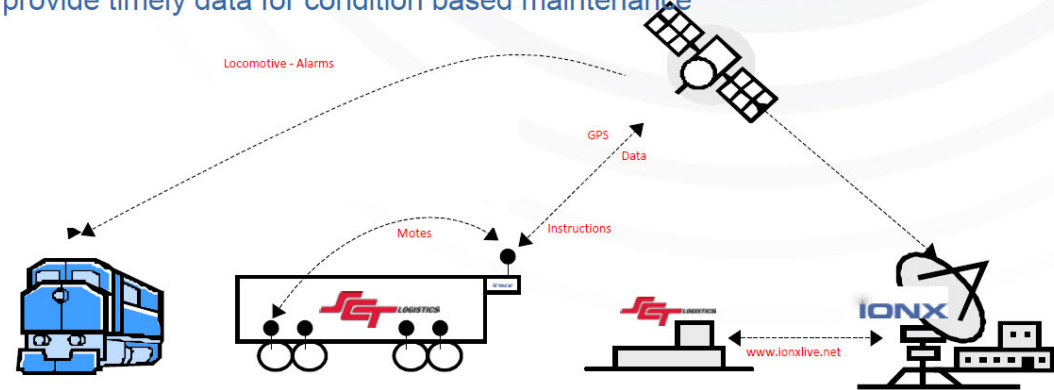
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18. The system of claim 5 wherein said sensor is selected from a group consisting essentially of temperature sensors, pressure sensors, strain sensors, load cell sensors, hand brake position sensors, magnetic sensors, vibration sensors, gyroscopes, acceleration sensors, hall effect sensors, piezoelectric microphones and switches.

Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

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Freight car install:
(1)Dual Mode Sat/Cell wireless CMU-351
(2)9 WSN-102 wireless temperature sensors per car

See Exhibit 2022, dated April 8, 2010; Slides 5,6.

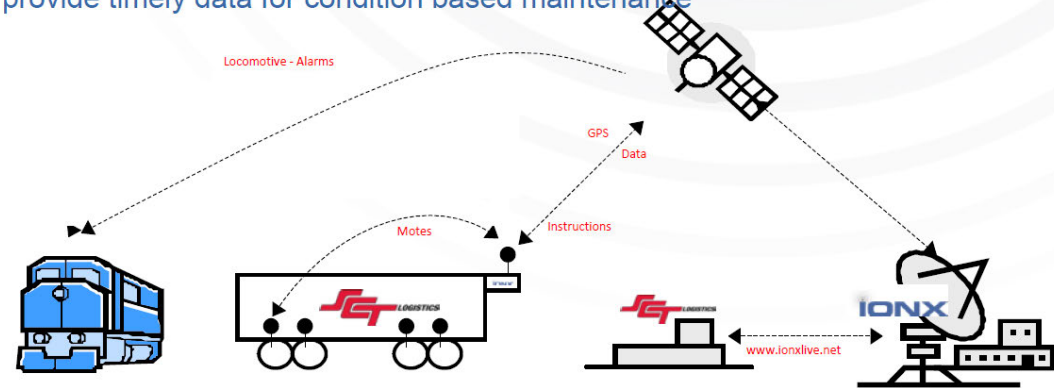
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20. The system of claim 5 wherein said alarm is determined using distributed event processing based on a comparison between current data and statistical models of behavior.

Objectives: Pilot Project

Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet

- Monitor bearing temperatures on ten wagons – validate technology
- Create actionable alarms for “hot” bearings – including locomotive alert system
- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

“Algorithm advancements have been made possible through continuous monitoring over the past three months. In addition to the existing alarm levels, several additional screening levels are now statistically evaluated:

- Peak Analysis is represented by percent count of temperature values greater than 93.3 C (200 F) against the total readings

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	• Distributions is the offset of a particular bearing temperature average vs. the wagon bearing temperature distribution • Ratios and Noise Factors are counts of temperature readings greater than 48.9 C (120 F) above ambient against the total readings.” See Exhibit 2050, dated 7/19/2010.
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21. The system of claim 5 wherein said alarms are determined based on a comparison of currently collected data versus data collected over a pre-determined preceding time period.

STAGE II CRITERIA

- Stage II is for further confirmation when necessary
- For those bearings that are “repeat offenders” on all three lists, request an acoustic detector readings
- In addition to or alternatively you can compare the temperature rise rates for the the offender bearing to the railcar average

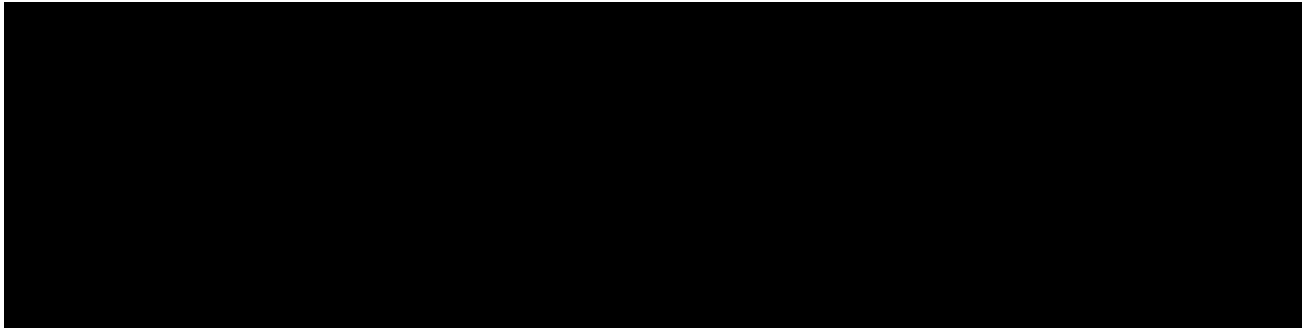
and entire IONX Bearing Health Monitoring Algorithm Slide Presentation

See Exhibit 2067, dated 6/22/2010.

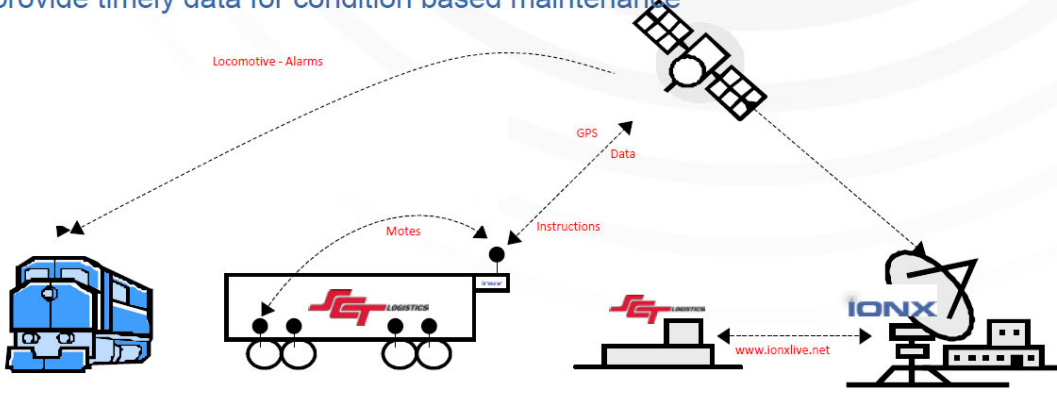
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22. The system of claim 5 wherein an alarm is raised based one or more of the following criteria:	
a. a pre-determined percentage of current data readings exceeds allowable peak readings;	“Level 2 Algorithms Stage I: Peak Analysis  • Normalize that count by the total number of readings for that bearing over the same time Frame.... Stage 2: Distributions 2. Skew of Bearing Temperature Average vs. Wagon Bearing temperature distribution • Calculate the bearing-specific temperature mean • Calculate the whole wagon bearing temperature mean and standard deviation
b. a pre-determined percentage of current data readings exceeds a determined value;	
c. a pre-determined percentage of current data readings exceeds a standard deviation from readings from the same railcar;	
d. a pre-determined percentage of current data readings exceeds a standard deviation from all railcars in the fleet; or	

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e. the rate of change of current data readings exceeds a pre-determined threshold.	• The skew represents the number of standard deviations of the bearing-specific mean from the wagon temperature mean.... Stage 3: Ratios and Noise Factors  See Exhibit 2050, dated 7/19/2010.
23. A monitoring device for monitoring temperature on a railcar, comprising:	“IONX has developed and proven a bearing condition monitoring system with action instructions for any critical alerts” See Exhibit 2154, dated August 2, 2011; Slide 13.

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	Objectives: Pilot Project <i>Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet</i> • Monitor bearing temperatures on ten wagons – validate technology • Create actionable alarms for “hot” bearings – including locomotive alert system • Collect data to validate algorithms that indicate bearing “condition” • To provide timely data for condition based maintenance  See Exhibit 2154, dated August 2, 2011; Slide 3.
a housing mountable on a railcar; a temperature sensor configured to be in thermal communication with a portion of the	“Progress and Milestones • Installed on ten wagons with more than sixteen months of service • Over 18 million temperature readings collected to date

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railcar to be monitored for temperature, which portion is external to said housing;

electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing;

a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing; and

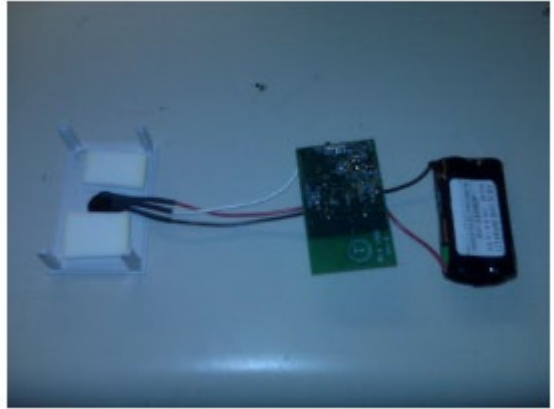
a communication device capable broadcasting information regarding the temperature sensed, said communication

- Over 8.5 million kilometers of freight mileage monitored”

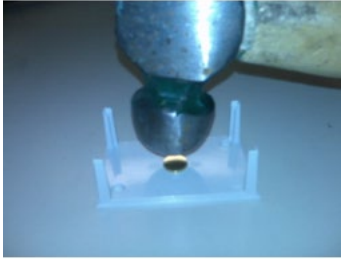


See Exhibit 2154, dated August 2, 2011; Slide 4.

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device positioned within said housing;	 See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).
wherein the power consumption of said monitoring device is managed by placing said monitoring device in a standby state and periodically awakening said monitoring device to collect readings from said temperature sensor and to transmit the information regarding the temperature sensed	“Power management: “wake/sleep” mode - The Edge asset monitoring system uses proprietary power management that minimizes the draw on the batteries. The communication management unit (CMU) has a defined message reporting schedule. When a message is scheduled to be generated and sent, the CMU powers on (wakes) to get location and other information from the sensors then transmits to the satellite. The CMU then powers off (sleeps) until its next scheduled power-on or wake-up period.” See June 2, 2010 email from Andrew Martin to Constantine Tarawneh and Brent Wilson, attaching Glossary of Terms dated September 18, 2008. Exhibits 2047, 2090 (metadata corroborating date). “Report regular temperature readings from each node to ionxlive every 1 to 8 hours. The reporting frequency may be modified mid-test to facilitate network or power constraints....

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via said communication circuitry.	Report alerts to ionxlive and locomotive display immediately, including wagon location and speed” See Exhibit 2162 at 5, dated December 21, 2009. “Andoni has configured one WSN to report temperature readings every 15 seconds” See Exhibit 2151, dated July 19, 2011, at 19. “End of presentation has latest progress on pushing algorithms onto WSN. Conclusion is that majority can be done at WSN, and just two algorithms will need to send Temperature Average, Number of samples, and Standard Deviation every 6 hours to the CMU.” See Exhibit 2152.
24. The monitoring device of claim 23 wherein at least a section of said temperature sensor is disposed outside of and spaced from said housing to be capable of contacting the surface of the railcar for which the temperature is to be monitored.	

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See Exhibit 2092 at 3, dated December 3, 2009; Exhibit 2168 (corroborating date).

See Exhibit 2020, dated April 4, 2010; Slide 2.



“4 bolt attached sensor (for smaller bearing end caps)”

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	 “2 bolt attached sensor (for larger bearing end caps)” See Exhibit 2020, dated April 4, 2010; Slide 3.
25. The monitoring device of claim 23 wherein said circuitry is configured to apply heuristics to analyze data collected from said temperature sensor to determine if a problem exists.	“End of presentation has latest progress on pushing algorithms onto WSN. Conclusion is that majority can be done at WSN, and just two algorithms will need to send Temperature Average, Number of samples, and Standard Deviation every 6 hours to the CMU.” See Exhibit 2152. “Objectives: Pilot Project <i>Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet</i> • Monitor bearing temperatures on ten wagons – validate technology

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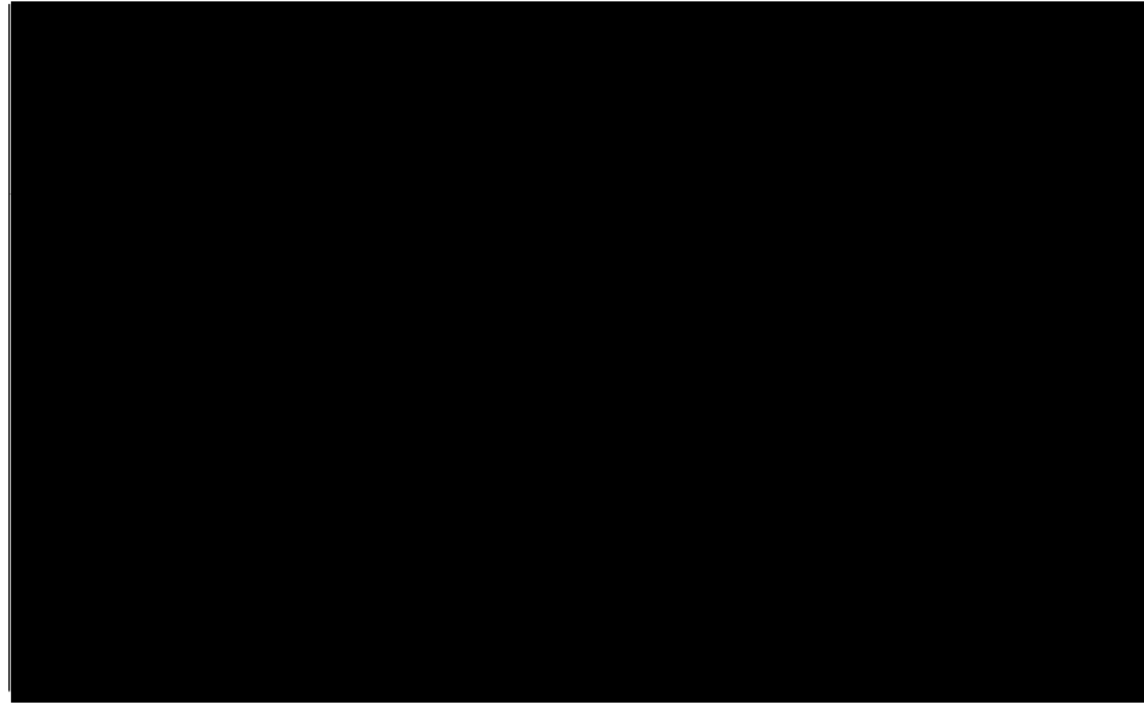
	• Create actionable alarms for “hot” bearings – including locomotive alert system • Collect data to validate algorithms that indicate bearing “condition” • To provide timely data for condition based maintenance” See Exhibit 2154, dated August 2, 2011; Slide 3. “IONX has developed condition based metrics to assess performance before a bearing is a burn-off risk IONX has identified other components (such as bogies) that effect bearing performance, and can now identify when those components are the cause” See Exhibit 2154, dated August 2, 2011; Slide 13. “March 28, 2010, Brent Wilson emailed the Amsted team that the SCT trial had begun, and that bearing temperatures would be monitored and subsequently analyzed to make the algorithms more robust.” See Exhibit 2041. Email string including the team of non-inventors and inventors discussing changing the parameter in the algorithm with the values sent from Brent and Andrew and updating the WSNs in the field. See Exhibits 2013 at ¶18, 2031, 2033.
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26. The system of claim 2 wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor devices (a) to determine if an actual failure exists and (b) to predict potential or imminent failures based on a statistical analysis of said collected data.	“IONX has developed condition based metrics to assess performance before a bearing is a burn-off risk IONX has identified other components (such as bogies) that effect bearing performance, and can now identify when those components are the cause” See Exhibit 2154, dated August 2, 2011; Slide 13. “March 28, 2010, Brent Wilson emailed the Amsted team that the SCT trial had begun, and that bearing temperatures would be monitored and subsequently analyzed to make the algorithms more robust.” See Exhibit 2041.
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Alert Instructions



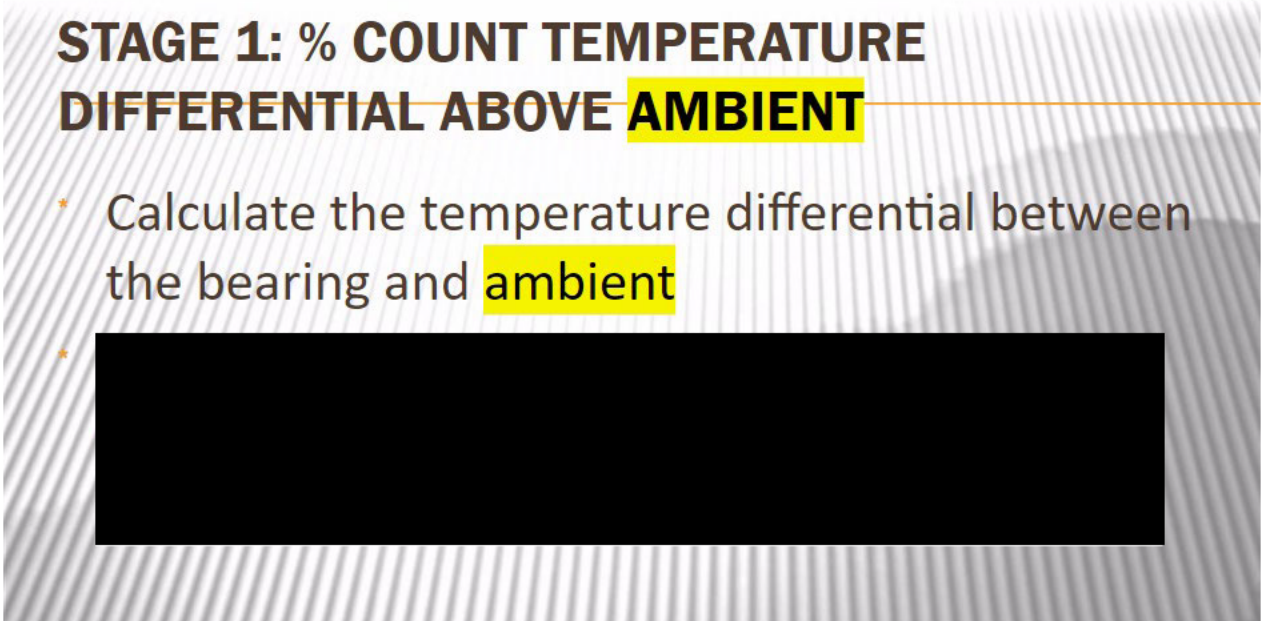
See Exhibit 2022, dated April 8, 2010; Slide 10

“Create actionable alarms for “hot” bearings – including locomotive alert system”

See Exhibit 2154, dated August 2, 2011; Slide 3.

“Actionable alarms for “hot” bearings

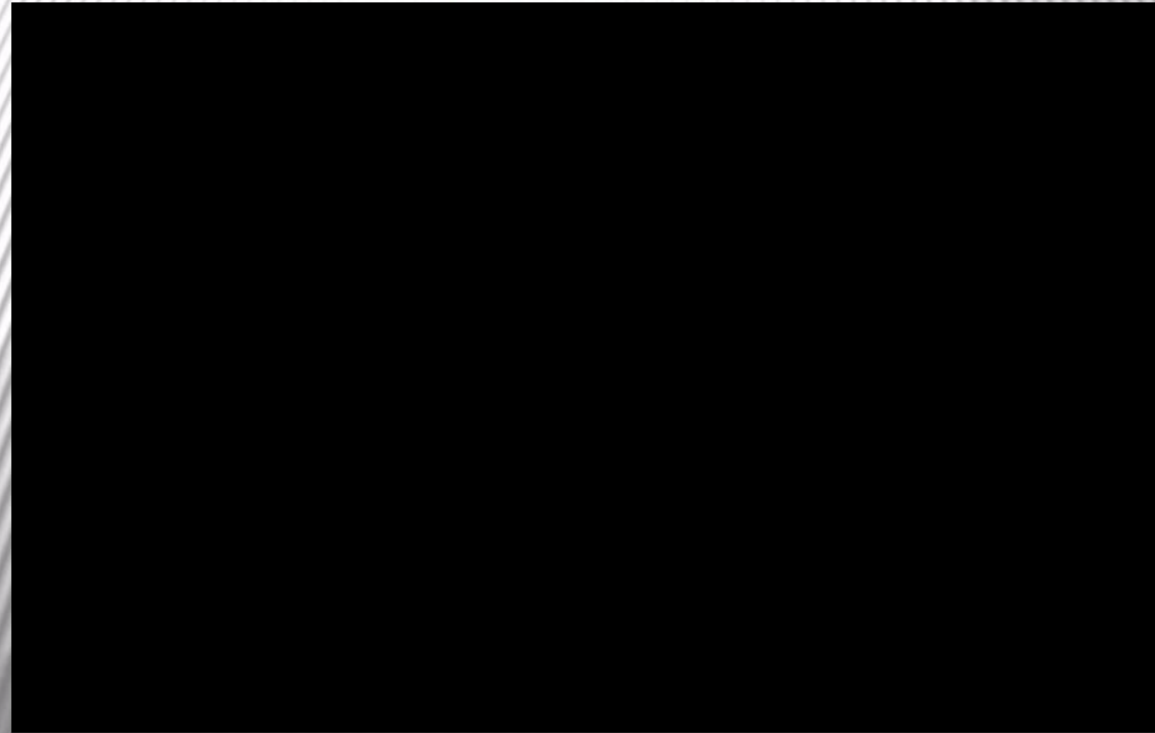
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	• Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest. • Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5.
27. The system of claim 2 further comprising a second temperature sensor located on said railcar for measuring ambient air temperature, wherein said system uses information obtained from said second temperature sensor about the ambient temperature to calibrate the temperature data received from said first sensor regarding the item	 STAGE 1: % COUNT TEMPERATURE DIFFERENTIAL ABOVE AMBIENT * Calculate the temperature differential between the bearing and ambient * [REDACTED]

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of the railcar being
monitored.

RESULTS: COUNTS OF TEMPERATURE READINGS ABOVE AMBIENT



See Exhibit 2067, dated June 22, 2021.

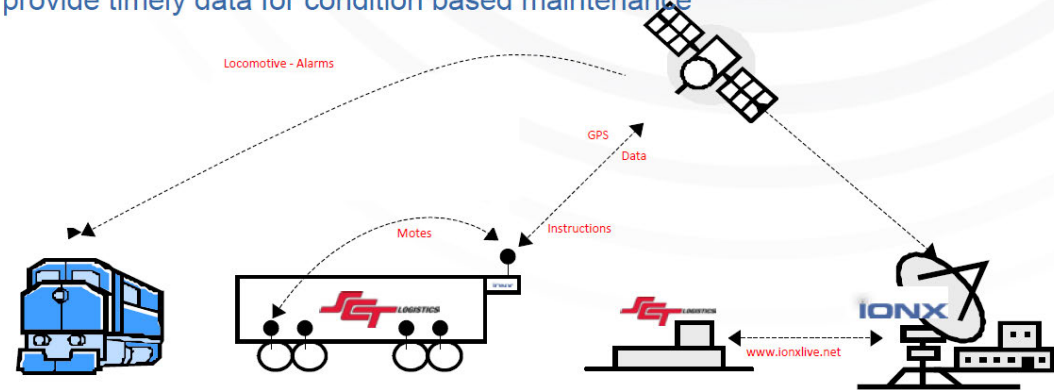
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28. The system of claim 2 wherein said communicating management unit is capable of communicating data and alarms to a remote location located off of the train of which the railcar is a part.

Objectives: Pilot Project

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- Monitor bearing temperatures on ten wagons – validate technology
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- Collect data to validate algorithms that indicate bearing “condition”
- To provide timely data for condition based maintenance



See Exhibit 2154, dated August 2, 2011; Slide 3.

“Actionable alarms for “hot” bearings

- Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest.

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	Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5.
29. The system of claim 2 wherein the power consumption of each of said sensor devices is managed by placing each said sensor device in a standby state and periodically awakening said sensor device to collect readings from said sensor device and to transmit the information regarding the parameter or condition being sensed via said communication circuitry.	"Power management: "wake/sleep" mode - The Edge asset monitoring system uses proprietary power management that minimizes the draw on the batteries. The communication management unit (CMU) has a defined message reporting schedule. When a message is scheduled to be generated and sent, the CMU powers on (wakes) to get location and other information from the sensors then transmits to the satellite. The CMU then powers off (sleeps) until its next scheduled power-on or wake-up period." See June 2, 2010 email from Andrew Martin to Constantine Tarawneh and Brent Wilson, attaching Glossary of Terms dated September 18, 2008. Exhibits 2047, 2090 (metadata corroborating date) "Report regular temperature readings from each node to ionxlive every 1 to 8 hours. The reporting frequency may be modified mid-test to facilitate network or power constraints.... Report alerts to ionxlive and locomotive display immediately, including wagon location and speed" See Exhibit 2162 at 5, dated December 21, 2009. "Andoni has configured one WSN to report temperature readings every 15 seconds"

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	See Exhibit 2151, dated July 19, 2011, at 19. “End of presentation has latest progress on pushing algorithms onto WSN. Conclusion is that majority can be done at WSN, and just two algorithms will need to send Temperature Average, Number of samples, and Standard Deviation every 6 hours to the CMU.” See Exhibit 2152.
30. The system of claim 2 wherein said communication management unit and said plurality of sensor devices form a wireless mesh network for said railcar.	Objectives: Pilot Project <i>Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet</i> •Monitor bearing temperatures on ten wagons – validate technology •Create actionable alarms for “hot” bearings – including locomotive alert system •Collect data to validate algorithms that indicate bearing “condition” •To provide timely data for condition based maintenance The diagram illustrates the IONX wireless monitoring system. It shows a locomotive and a freight train (labeled SCT LOGISTICS) equipped with motes (sensors). The locomotive sends 'Locomotive - Alarms' to a satellite. The freight train's motes send 'GPS Data' to the satellite. The satellite sends 'Instructions' to the motes. The motes are connected to a ground station labeled 'IONX' with the website 'www.ionxlive.net'.

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See Exhibit 2154, dated August 2, 2011; Slide 3.

Series 3 - Wireless car-based network

Radio off most of time
Redundant paths (mesh)
Scalable
Frequency Agile
Coexistence with Wi-Fi & Bluetooth
Secure (access control & encryption)
Intelligent routing (node power)

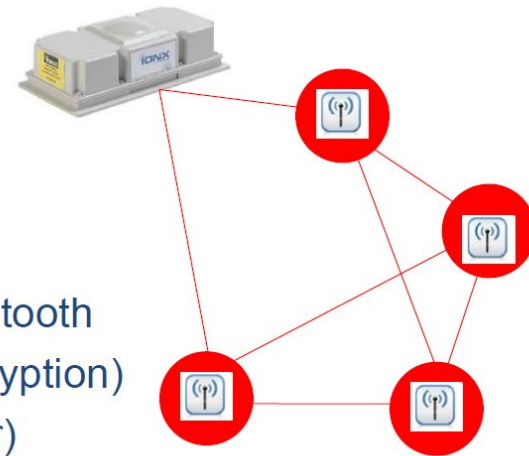
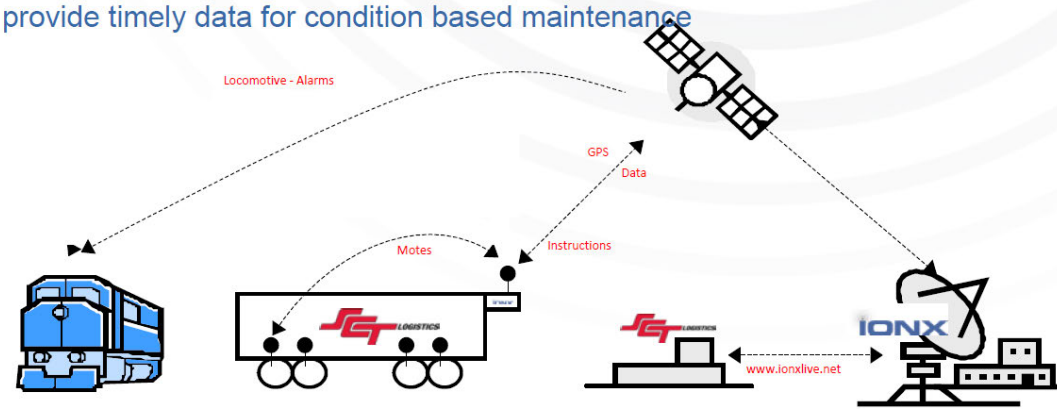


Exhibit 2017, dated March 20, 2010, slide 9.

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31. The system of claim 5 wherein the power consumption of each of said sensing units is managed by placing each sensing unit in a standby state and periodically awakening said sensing unit to collect readings from said sensor and to transmit information via said communications circuitry.	“Power management: “wake/sleep” mode - The Edge asset monitoring system uses proprietary power management that minimizes the draw on the batteries. The communication management unit (CMU) has a defined message reporting schedule. When a message is scheduled to be generated and sent, the CMU powers on (wakes) to get location and other information from the sensors then transmits to the satellite. The CMU then powers off (sleeps) until its next scheduled power-on or wake-up period.” See June 2, 2010 email from Andrew Martin to Constantine Tarawneh and Brent Wilson, attaching Glossary of Terms dated September 18, 2008. Exhibits 2047, 2090 (metadata corroborating date) “Report regular temperature readings from each node to ionxlive every 1 to 8 hours. The reporting frequency may be modified mid-test to facilitate network or power constraints.... Report alerts to ionxlive and locomotive display immediately, including wagon location and speed” See Exhibit 2162 at 5, dated December 21, 2009. “Andoni has configured one WSN to report temperature readings every 15 seconds” See Exhibit 2151, dated July 19, 2011, at 19. “End of presentation has latest progress on pushing algorithms onto WSN. Conclusion is that majority can be done at WSN, and just two algorithms will need to send Temperature Average, Number of samples, and Standard Deviation every 6 hours to the CMU.”
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	See Exhibit 2152.
32. The system of claim 5 wherein said communication management unit is capable of communicating with a remote location located off of a train of which said railcar is a part.	Objectives: Pilot Project <i>Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics fleet</i> • Monitor bearing temperatures on ten wagons – validate technology • Create actionable alarms for “hot” bearings – including locomotive alert system • Collect data to validate algorithms that indicate bearing “condition” • To provide timely data for condition based maintenance  See Exhibit 2154, dated August 2, 2011; Slide 3. “Actionable alarms for “hot” bearings

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	• Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest. • Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm's severity. Each alarm level is associated with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5.
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