

~~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.

IPR2023-00539

PATENT NO. 9,981,673

ISSUED: MAY 29, 2018

**TITLE: SYSTEM AND METHOD FOR MONITORING
RAILCAR PERFORMANCE**

EXHIBIT 2161

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

AMSTED 2161
IPR2023-00539

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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 1) filed by Hum Industrial Technology, Inc. (“Hum” or “Petitioner”) challenging the validity of Claims 1–18 and 20–32 (the “Challenged Claims”) of U.S. Patent No. 9,981,673 (“the ’673 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. 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.

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

II. MATERIALS CONSIDERED

7. 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.

8. 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 ’673 Patent.

9. 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.

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

III. COMPENSATION

11. I am being compensated at my regular rate of \$600/hour. My compensation is in no way dependent on the testimony I give or on the outcome of this proceeding, and my compensation in no way affects the substance of my statements and opinions in this Declaration.

12. I have no financial interest in this case, the Litigation, Petitioner, or the '673 Patent.

IV. SUMMARY OF MY OPINIONS

13. The following table summarizes the grounds of challenge (“Grounds”) raised in the Petition:

Grd.	Sec.	References	Challenged Claims
1	§ 103	LeFebvre	1–7, 10–18, 20–22
2	§ 103	LeFebvre in view of Barone	8, 9
3	§ 103	Armitage	1, 2, 4, 6–11, 13
4	§ 103	Armitage in view of LeFebvre	3, 5, 12–18, 20–22

14. After a review of the '673 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.

V. LEGAL PRINCIPLES

15. Counsel for Patent Owner has informed me of the legal principles that apply in this proceeding.

16. A prior art reference can disclose a limitation that is not expressly disclosed in the reference if it is “inherently present” in the reference. I further understand that to be “inherently present,” the missing disclosure must necessarily and inevitably be present in the element or process described in the reference. It is

my understanding that a limitation is not disclosed by inherency if the missing limitation is only probably present or if there is merely a possibility that it is present.

17. A claim is invalid as obvious under 35 U.S.C. § 103 if the differences between the subject matter sought to be patented and the prior art are such that the subject matter of the claim as a whole would have been obvious at the time of the patent's filing date to a person having ordinary skill in the art. I have been informed that the following factors are used to determine whether or not the claimed subject matter would have been obvious: (i) the scope and content of the prior art; (ii) the differences between the prior art and the claimed invention; (iii) the level of ordinary skill in the field of the invention; and (iv) any relevant objective considerations of non-obviousness.

18. A party asserting obviousness based on a combination of prior art references must demonstrate that one of ordinary skill in the art would have been motivated to combine the teachings of those references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so. It is my understanding that it is not enough to show that one skilled in the art could combine elements of multiple references, but instead there must be some reason that would have prompted a person of ordinary skill in the art to combine the elements in the way the claimed invention does. I understand that

there must be some reasoned explanation as to why one of ordinary skill in the art would combine the references.

19. A combination of references would not have been obvious if the alleged modification(s) to be made to the reference(s) would have been inconsistent with a reference's stated goals or would have rendered the combination inoperable for its intended purpose. I further understand that for something to have been obvious, the party asserting obviousness must explain why a POSITA would have selected components for combination in the manner claimed.

20. It is my further understanding that obviousness cannot be based on a hindsight combination of components selected from prior art references. I also understand that an invention would not have been obvious simply because all of the elements of the invention may have been known separately in the prior art.

21. I understand that claims must be enabled by the original disclosure of the patent. For the claims to be enabled, the information contained in the disclosure must be sufficient to inform those skilled in the relevant art how to make and use the claimed invention without undue experimentation. I also understand the original disclosure must contain a written description of the claimed invention. I understand that the written description requirement is separate and distinct from the enablement requirement. To satisfy the written description requirement, the original disclosure must describe (in writing or drawings) the claimed invention in sufficient detail that

one skilled in the art can reasonably conclude the inventor had possession of the claimed invention. In other words, the question is whether one of skill in the art can discern or visualize, from the original disclosure, that the named inventor actually invented the subject matter later claimed.

22. I understand that a reference patent, i.e. an alleged prior art patent or patent publication used in a ground to prove invalidity, is only entitled to claim the benefit of the filing date of its provisional application if the disclosure of the provisional application provides support for the claims in the reference patent in compliance with § 112 ¶ 1. In other words, to be entitled to the provisional priority date, therefore, the provisional application's written description must provide written description support for the claims of the later patent or patent publication. Additionally, the subject matter relied upon in the ground must be effectively filed, i.e. be present, in the provisional application. If either of these requirements are not met, the reference is not entitled to its provisional filing date as an effective filing date.

23. I have been informed and I understand that claim construction is a matter of law and the construction of a claim term will be determined by the Board. In this declaration, I have been informed and I understand that the claim terms should be interpreted under "the Phillips standard." I have been informed and I understand that under the Phillips standard, claim terms are given their ordinary and customary

meaning as understood by a person of ordinary skill in the art at the time of the invention in light of the claim language and the patent specification. I have been informed and I understand that the claim terms, as construed, encompass the embodiments disclosed in the specification. I have been informed and I understand that the patentee can serve as their own lexicographer. As such, if the specification provides a definition of a claim term, I understand that I should interpret that claim term in light of the particular definition provided in the specification. I further understand that different claim terms in a patent are presumed to have different meanings. I further understand that extrinsic evidence such as dictionaries are among the tools that can assist the Board in determining the meaning of particular claim terms to those of skill in the art.

VI. PROSECUTION HISTORY

24. I understand that during the prosecution of the '673 Patent, the Examiner considered a combination of references (Searle and Baker) and determined that they do not disclose or suggest quantifying the extent of a deviation from acceptable operating conditions and assigning a severity level to this quantification, i.e., the “applying a heuristic to said received data to determine deviations from nominal operating conditions [and] assigning a severity level to said deviations from nominal operating conditions,” as required by limitations 1(b)-1(c) of independent claim 1.

25. As I explain below, Petitioner’s asserted combination of LeFebvre and Armitage likewise fails to disclose limitations 1(b)-1(c) for the same reasons that Searle and Baker fail to disclose those limitations.

VII. LEVEL OF ORDINARY SKILL IN THE ART

26. In my opinion, as explained in ¶¶ 36-40 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.

VIII. CLAIM CONSTRUCTION

27. Petitioner’s expert, Mr. Ricca, offered the opinion that the Board should adopt the plain and ordinary meaning of these terms “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.

28. Patent Owner proposed constructions for three terms: (1) “a heuristic”/“heuristically analyzing”, (2) “nominal,” as used in the phrase “nominal operating conditions”; and (3) “severity level.” I understand that Patent Owner accepts the Board’s construction of “heuristic” as “a rule, algorithm, function,

formula, graphing function, or similar mechanism applied to data to assist in analyzing and/or interpreting the data” for this proceeding only, without conceding that it is correct.

A. “nominal” (Independent Claims 1 and 8)

29. The phrase “nominal operating conditions” appears in claims 1 and 8. For example, claim 1 contain the limitation, “applying a heuristic to said received data to determine deviations from nominal operating conditions.” The Board construed “nominal operating conditions” to mean “normative or expected conditions based on trends, conditions of other components, ambient conditions, and predetermined values.” However, this construction is much narrower than the meaning given to it in the ’673 Patent because it requires “nominal operating conditions” to be based on all four of (1) trends; (2) conditions of other components; (3) ambient conditions; and (4) predetermined values. Further, neither the word “normative” nor the concept it describes is found anywhere in the intrinsic evidence. Therefore, based on my review of the intrinsic evidence as cited by the Board, I believe a suitable construction would be “expected conditions based on at least one of trends, conditions of other components, ambient conditions, and predetermined values.”

30. In my opinion, the Board’s construction of “nominal operating conditions” is not the plain and ordinary meaning of the term which, in the context of the ’673 Patent, is “expected conditions.”

B. “severity level” (Independent Claims 1, 2 and 23)

31. The phrase “severity level” appears twice in each of claims 1 and 8. For example, claim 1 contains these limitations:

- c. assigning a **severity level** to said deviations from nominal operating conditions; and
- d. determining an alarm condition based on said assigned **severity level**.

32. One of the features of the ’673 Patent that distinguishes it over the prior art is “the ability to determine the severity of detected conditions to determine if immediate alarms should be raised to facilitate human intervention.” Ex. 1001. 2:15-22. The Patent further discloses that severity “levels” for raising alarms are discrete, e.g., Stage 1, Stage 2, Stage 3 or Stage 4. *Id.*, 13:33-14:3. The explicit claim language is “assigning a severity level based on deviations from nominal operating conditions.” A POSITA would therefore understand that the “severity level” assigned in limitation 1(c) is “one of a plurality of known values indicating seriousness.”

33. The Board construed “severity level” as “a type of fault that requires a particular action.” This construction is incorrect for several reasons. First, a

“severity level” is not a “type of fault.” Examples of a “type of fault” would be “bearing fault” (Ex. 1001, table in col. 8), or “track damage” (Id. table at col. 9). These are not “severity levels.” Further, “fault” is only used the ’673 Patent in the context of heuristics and not in connection with “severity level.”

34. A “level” is not a fault and a “severity level” is not a type of fault. Further, a fault is not a “level” or a “severity level.” I am not aware of any authority for the proposition that “severity level” means “fault” or that the terms are synonymous or interchangeable.

35. A “level,” as used in the Challenged Claims, is one of a plurality of known values. The ’673 patent refers to “the ability to **determine the severity of detected conditions** to determine if immediate alarms should be raised to facilitate human intervention.” Ex. 1001 at 2:15-22. A “bearing fault,” for example, cannot be a “severity level” for the simple reason that different bearing faults may have different levels of severity. A bearing that fails on a non-critical component may not be severe at all, while a faulty bearing on a wheel may be critically severe.

36. The ’673 patent teaches “leveled alarms,” which range from “Stage 1” identifying an alarm condition that need only be sent to base station for logging and future reference to “Stage 4” which requires immediate action to stop the train and perform emergency maintenance. Ex. 1001, 13:30-14:3. These are examples of the claimed “severity levels”

37. I have accorded all terms not discussed in this section their plain and ordinary meanings to a POSITA.

IX. 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 1–7, 10–18, and 20–22 are obvious over LeFebvre

1. Claim 1

a. LeFebvre does not assign severity levels and does not determine an alarm condition based on a severity level

38. Limitation 1(c) recites, “assigning a severity level to said deviations from nominal operating conditions.” LeFebvre fails to disclose this limitation.

39. LeFebvre does not disclose or suggest the step of “assigning a severity level to said deviations from nominal operating conditions,” or the step of “determining an alarm condition based on said assigned severity level,” as required by limitations 1(c) and 1(d). Further, the passages from LeFebvre cited in the Petition do not disclose any component of LeFebvre for “assigning a severity level” to any detected behavior. Neither Petitioner nor its expert identify any such disclosure.

40. As explained above, the phrase “assigning a severity level” means “assigning one from of a plurality of known values indicating seriousness.” LeFebvre, by contrast, discloses that when repetitive forces of a sufficient

magnitude are inferred, the instrumented pads send relevant attributes and timing to the data control unit. See LeFebvre, Ex. 1005, [0055]. A POSITA would not consider sending “relevant attributes and timing” to be the same thing as “assigning a severity level.” The crux of Petitioner’s arguments with respect to limitation 1(c) overlook the express claim language of “assigning a severity level to [the] deviations from nominal operating conditions.” In fact, Petitioners’ arguments explicitly acknowledge that LeFebvre simply “distinguishes between (a) deviations from expected operating conditions that are not severe enough to raise an alarm; and (b) deviations that are severe enough to raise an alarm.” Petition at 23. Thus, Petitioner itself acknowledges that LeFebvre does not assign a severity level.

41. LeFebvre’s determination is binary – either a condition is severe or it is not, depending whether a threshold has been exceeded. Thus there is only one level – severe – as there is no “plurality of levels.” “Not severe” is not a level of severity, and conveys no relative information as to how severe the condition is.

42. The successive limitations 1(b)-1(d) recite that, once a deviation is determined, the deviation is quantified and assigned an appropriate severity level based on a seriousness of the deviation, and an alarm condition commensurate with the seriousness of the assigned severity level is determined. LeFebvre does not disclose any assignment indicating the seriousness of the measured unsatisfactory

behavior. Rather, LeFebvre merely monitors possible defects (Ex. 1005 [0058]-

[0062], [0064]-[0065]) to determine if sensor data is irregular, and, if so, an alarm is raised. Merely identifying a risk condition is not assigning a severity level from a plurality of levels.

43. LeFebvre does not assign multiple levels of severity to the measured conditions and report unsatisfactory behavior in the form of different alarms based on multiple severity levels. The Petition thus fails to show that LeFebvre, in view of the skill of a POSITA, discloses multiple levels of severity for a measured condition.

44. The Board wrote in the Institution Decision that “LeFebvre sends alarms to locomotives, a central data handling site, an owner, or operator based on the severity level, i.e., how poorly a component is behaving.” Paper 10 at 18 (citing Ex. 1005 at ¶¶ 52, 95; Petition at 24). However, a review of the cited paragraphs confirms that LeFebvre contains no such disclosure. Paragraph 52 states that an “alarm message must get through from any railcar to the locomotive or to the remote data handling service as quickly as possible” but says nothing about sending messages based on severity. Paragraph 95 states that the disclosed data control unit “performs the assessments described above for the inference engine to check if the freight car, its trucks or wheels or axles are behaving sufficiently poorly that a report to the central data handling location or owner or operator or

locomotive is needed.” This also does not disclose sending a message based on severity, but rather discloses a simple threshold consisting of “severe” and “all’s well.” By definition, if a condition is not severe, there is no severity level.

45. The Board asserted on p. 16 of the Institution Decision that “LeFebvre’s inference engine uses algorithm heuristics to convert or correlate data measured at instrumented pads 16 to operating conditions (e.g., loads, frequencies, forces) that are compared to thresholds and alarm levels to identify deviations from expected operating conditions.” While such a comparison is disclosed in LeFebvre at [0058], the reference to “alarm levels” is to a threshold needed to raise an alarm, and does not imply a “level of severity” on which the consequent alarm is based. In LeFebvre, all alarms are of equal severity.

46. Further, Petitioner’s expert did not apply the correct standard for motivation to combine. He says only that “A PHOSITA could have followed the teachings of LeFebvre to arrive at the claimed systems and devices with a reasonable expectation of success” (Ex. 1003, [0068]) and “a PHOSITA could have made any required adjustments or modifications to LeFebvre’s disclosed systems and sensors with a reasonable expectation of success and without undue experimentation” (Id., [0069]). The issue is not whether a POSITA could have done such things, but whether the POSITA would be been motivated to do them.

47. In my opinion, Petitioner has not established that independent claim 1 is obvious in view of LeFebvre. Therefore, Petitioner also has not established that claims 2-7 and 13, which depend from independent claim 1, are obvious over LeFebvre.

2. **Claim 10**

48. Claim 10 is independent. Claims 11 and 12 depend from claim 10.

a. **LeFebvre does not disclose step 10[c]: “determining if said temperature of the desired part is outside an acceptable range of temperatures”**

49. LeFebvre fails to disclose or suggest the step of “determining if said temperature of the desired part is outside an acceptable range of temperatures,” as required by independent claim 10. LeFebvre merely discloses an instrumented pad 16 that may comprise several temperature sensors 5 which “monitors relative changes in temperature against other bearings.” Ex. 1005, [0033], [0058]. As with limitation 1(b) discussed above, Petitioner equates the disclosed “acceptable range of temperatures” with a relative comparison with other bearings on the railcar. Petitioner and its expert are wrong.

50. LeFebvre discloses that its monitoring system “is programmed to compare information from all of the trucks on the railcar.” LeFebvre, [0036]. Secondly, LeFebvre expressly discloses that the “temperature sensor in instrumented pad 16 monitors relative changes in temperature against other

bearings.” LeFebvre, [0058]. Such a technique suffers from a severe drawback -- if all the bearings on a car are running hot, the system may miss a hot temperature reading because it does not deviate sufficiently from the car average. This is insufficient to meet the “acceptable range of temperatures” limitation because the fact that all the bearings are hot fails to bring any of them into an “acceptable range.”

51. Because step 10[c] is not disclosed in LeFebvre, step 10[d], “transmitting an alarm if in step (c) it is determined that the temperature of the desired part is outside an acceptable range,” is also not disclosed.

52. In my opinion, Petitioner has not established that independent claim 10 is obvious over LeFebvre. Therefore, Petitioner has not established that claims 11-13, which depend from independent claim 10, are obvious over LeFebvre.

3. Claim 14

53. Claim 14 is independent.

a. LeFebvre does not determine whether an actual failure exists and does not apply statistical analysis to sensor data as required by claim 14

54. LeFebvre fails to disclose or suggest a “communication management unit” that performs the steps of “heuristically analyzing said received [sensor] data to determine if an actual failure exists on said railcar or to predict potential or imminent failures based on a statistical analysis of said received data,” as required

by independent claim 14. A first analysis applies heuristics “to determine if an actual failure exists” and the second analysis applies heuristics for a prediction “based on a statistical analysis” of the received sensor data.

55. LeFebvre is devoid of any mention or suggestion of statistical analysis. In ¶ 112 of the Ricca Declaration (Ex. 1003), Mr. Ricca points to the disclosure in [0037] of LeFebvre of a “distributed inference engine,” as supposedly performing “statistical analysis.” However, LeFebvre does not disclose any such “statistical analysis” and it is not inherent in a “distributed inference engine.” For example, if I am told that $x + 4 = 12$, I can infer that $x = 8$ without performing any statistical analysis. Transporting this observation to LeFebvre, “inference” about the status of the railcar can be performed without statistics. LeFebvre at [0041] discloses that “any inferences or data analysis performed at unit 25 takes account of information from **all** the sensors on all the pads on the truck.” No statistical sampling takes place because all the sensors are considered.

56. The '673 Patent explains: “The 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.” Ex. 1001, 2:63-3:1. Accordingly, a POSITA familiar with the specification and claims of the '673 Patent would recognize that the analysis

required by independent claim 14 necessarily involves statistical analysis rather than just the mere aggregation of collected sensor data to form an inference as to a condition of a railcar. Limitation 14(c) also requires that the specific “results of said analysis” must be communicated to an off-railcar location.

57. Petitioner ignores the fact that both of the different words “heuristics” and “statistical analysis” are used in the claim for different purposes and relies on the same disclosure in LeFebvre for both requirements. Petition, 36-37; Ex. 1005 [0058]-[0066]. I understand that such reliance is improper under the principles of claim construction. Petitioner merely relies on the disclosure in LeFebvre of forming an “inference” of a measured condition via an inference engine. Petition, 37. Inference does not require either heuristics or statistical analysis, let alone both. Petitioner fails to point to any disclosure in LeFebvre that discloses a method utilizing statistical analysis for the simple reason that no such disclosure exists. Petition, 36-37 (not identifying or even applying the words “statistical analysis” to LeFebvre).

58. 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 and is therefore entirely different from performing a “statistical analysis.”

59. 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. Thus, LeFebvre does not detect “potential or imminent failures based on a statistical analysis of said received data,” as required by claim 14.

60. In my opinion, Petitioner has not established that independent claim 14 is obvious over LeFebvre. Therefore, Petitioner has not established that Claims 15-18 and 20, which depend from independent claim 14, are obvious.

4. Claims 21 and 22

61. Claim 21 is independent and includes limitation 21(c): “analyzing said collected data by applying heuristics thereto to (i) determine if an actual failure exists and (ii) to predict potential or imminent failures based on a statistical analysis of said collected data.” Claim 22 depends from claim 21.

62. LeFebvre fails to disclose or suggest the use of heuristics to “(i) determine if an actual failure exists and (ii) to predict potential or imminent failures based on a statistical analysis of said collected data.” As explained above, LeFebvre also fails to disclose any “statistical analysis.” In my opinion, Petitioner has not established that independent claim 21 is obvious over LeFebvre. Therefore, Petitioner has not established that claim 22, which depends from independent claim 21, is obvious.

B. Ground 2: Petitioner has failed to show a reasonable likelihood that Claims 8 and 9 are obvious over LeFebvre in view of Barone

63. Claims 8 and 9 depend indirectly from claim 1. As explained above LeFebvre fails to disclose, teach, or suggest limitations 1(b), 1(c), and 1(d) of independent claim 1. Barone, which is merely relied upon by Petitioner for certain limitations of dependent claims 8 and 9 (and not claim 1), fails to cure the deficiencies of LeFebvre with respect to independent claim 1. Neither LeFebvre nor Barone discloses a “severity level,” as required by claim 8.

64. In my opinion, Petitioner has not established that independent claim 1 is obvious over LeFebvre. Therefore, Petitioner has not established that claims 8 and 9, which depend from independent claim 1, are obvious.

C. Ground 3: Petitioner has failed to show a reasonable likelihood that Claims 1, 2, 4, 6–11, and 13 are obvious over Armitage

1. Priority Date of the ’673 Patent

65. I have reviewed the declarations of Andrew Martin and Jay Monaco as well as the exhibits cited therein, respectively. I understand that Petitioner asserts that Armitage is prior art to the '673 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 the 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 '673 Patent it is applied to, depending on whether Petitioner is able to prove Armitage is entitled to its 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.

66. 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.

67. I understand that Armitage would not be prior art if the inventors of the '673 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.

68. 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.

69. 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.

70. The purpose of the railcar monitoring system described and claimed in the '673 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 3:15-20.

71. It is my opinion that actual reduction to practice of the invention claimed in the '673 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.

72. 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 '673 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 '673 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 materials, I further understand that the methods claimed in the '673 Patent were a natural use for the structures disclosed in the March 2010 installations.

73. 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. Claim 1

74. In the event that Armitage is deemed to be prior art to any of the Challenged Claims, I explain in this and the following sections why the Challenged Claims are patentable even in view of Armitage.

75. Limitation 1(b) of claim 1 recites: “applying a heuristic to said received data to determine deviations from nominal operating conditions.” This determining how much an operational characteristic differs from expected

conditions. Armitage merely determines whether a sensor's data value is outside of a threshold value of other sensor data. Armitage does not consider expected operating conditions of the railcar. In Armitage, it is simply assumed that when a sensor's data is far enough away from the average of all sensor data that the corresponding component may experience a failure. Therefore, a value that Armitage may regard as acceptable (because it is consistent with other sensor values) can be wildly out of a nominal range.

76. In Armitage, sensor nodes 121-124 are coupled to railway car 110. Ex. 1006 at Fig. 1; [0026]. "Each of sensor nodes 121-124 transmit [] the monitored information about the undercarriage portion to control node 130 coupled to the railway car 110 ... Control node 130 processes [] the sensor information to determine a fault condition for the undercarriage portion. *Id.* This determination merely involves thresholding based on trend analysis. Ex. 1006 at [0029]-[0030]. The threshold value used in the thresholding process is dynamically determined based on a pool of sensor data. *Id.*, [0030]. The dynamically determined threshold value can include a running average of the temperature measurements for a population of sensors (e.g., all wheels on the railway car), a failure threshold dynamically determined based on a time series of sensor data from all sensors of the population of sensors, an upper limit for a dynamically normalized range of operation for the population of sensors, or a lower limit for a dynamically

normalized range of operation for the population of sensors. Ex. 1006, [0029], [0042], [0043].

77. The dynamic normalization of Armitage results in a change of the range of operational values for an undercarriage element in real time based on sensor data. Ex. 1006, [0043]. During prosecution, the Armitage Applicant argued that the claim limitation “monitoring for patterns of deviation in the information from a population of sensors” is a distinct type of analysis from merely using a predetermined static threshold that is set in advance like the Sakitani art applied by the Examiner against Armitage. Ex. 2005, at 82-83. The Armitage Applicant explained that “Sakatani merely discusses individual sensors detecting fault conditions based on predetermined thresholds.” *Id.* at 82 In view of these arguments contrasting Sakatani to the Armitage Invention, the Examiner issued a Notice of Allowance. *Id.* at 47. These statements highlight differences in Armitage from conventional pre-established threshold techniques.

78. In Armitage, the threshold of interest has been dynamically determined, e.g., by establishing low and high thresholds that are three standard deviations away from the running average of the pool of sensor data. Ex. 1006, [0041]. Armitage explains that the following operations are performed: (1) detecting when a sensor reading deviates from the dynamically determined threshold value by at least a certain amount; and (2) determining that a fault

condition does or could exist at the time such a detection is made. Ex. 1006, Fig. 4; [0030], [0041]-[0043].

79. Limitation 1(b) of claim 1 recites: “applying a heuristic to said received data to determine deviations from nominal operating conditions.” This determining how much an operational characteristic differs from expected conditions. Armitage merely determines whether a sensor’s data value is outside of a threshold value of other sensor data. Armitage does not consider expected operating conditions of the railcar. In Armitage, it is simply assumed that when a sensor’s data is far enough away from the average of all sensor data that the corresponding component may experience a failure.

80. A POSITA would understand that Armitage does not disclose limitation 1(b). For example, a POSITA would recognize that Armitage’s threshold determined dynamically via a normalization process does not take into account expected operating conditions for the undercarriage elements. Moreover, this methodology does not effectively accommodate trains having individual railcars of varying age and wear and tear. Consider an aging railcar all of whose bearings are relatively old and worn. Determining a dynamic threshold of a population of sensor data in which each sensor is providing data from bearings equally old and worn would be incapable of determining whether one of the sensors began to “deviate from nominal conditions” because all of the bearings are

old and worn. Second, if a train has multiple railcars with bearings having different wear and tear, then finding outlier sensor data from such a train would overlook potential problems and report problems that were not necessarily outside of expected operating conditions. The outlier might indicate performance that is **better** than that of the other sensors. Therefore, a POSITA would recognize that Armitage's degree of deviation is not necessarily the same as, or equivalent to, the requirements of limitation 1(b). Consequently, the claimed solution is different from, and superior to, that of Armitage.

81. In my opinion, Petitioner has not established that independent claim 1 is obvious over Armitage. Therefore, Petitioner has not established that claims 2, 4, 6-9, and 13, which depend from independent claim 1, are obvious.

3. Claim 10

82. Claim 10 is independent.

83. Armitage and the knowledge of a POSITA fail to disclose or suggest “(a) sensing the temperature of a part of the railcar other than the desired part by use of a temperature sensor in thermal communication with said other part; and (b) determining the temperature of the desired part by use of the temperature sensed in step (a),” as required by independent claim 10. Armitage does not disclose the specific way sensor nodes are coupled to the railcar. Petitioner uses this silence to

suggest, without explanation, that knowledge of a POSITA would render the claim limitations obvious. Petition, 65-67.

84. Petitioner argues that “Armitage does not state that the temperature sensors are attached directly to the wheel bearing.” Petition at 65. Petitioner then selects portions of Armitage’s disclosure at [0034] explaining an embodiment in which sensor nodes may be coupled to a non-rotating portion of the railcar such as a bracket. *Id.*; Ex. 1006, [0034]. Petitioner does not address how or what a POSITA would conclude based on different embodiments in the same paragraph, or why such a conclusion might be reached. For example, Armitage also explains that “sensor nodes 320-327 could be coupled ***to a rotating portion of the associated wheel assembly***, such as an axle, driveshaft, wheel, or other rotating member” *Id.*

85. Petitioner does not explain how Armitage’s sensor node, being mounted on a bracket, would even be in “thermal communication” with another part of the railcar or how the system determines the temperature of the other (unnamed and undisclosed) part based on the measured temperature of a different part. Petition, 65-67.

86. Armitage’s sensor nodes 121-124, 320-327 (i) are coupled to undercarriage elements 111-114, 312-315 that are being monitored (e.g., a bearing assembly), and (ii) are configured to measure the temperature of the undercarriage

element. Nowhere does Armitage disclose that (1) the temperature of a first part (e.g., a bearing assembly) is determined based on the temperature of another part (e.g., a wheel or a bracket) and/or (2) the temperature of a rotating portion of the first part (e.g., the bearing) of the undercarriage element is determined based on the temperature of a non-rotating portion of the first part (e.g., the bearing mount).

Armitage simply teaches that a contact temperature sensor or a non-contact temperature sensor can be used to monitor a temperature of an undercarriage element. Because the temperature of the desired part is directly measured, there is no need in Armitage for transforming or otherwise using the temperature of another part (e.g., a wheel or bracket) to obtain the temperature of the undercarriage element (e.g., the bearing). Armitage does not contemplate such a configuration, so Petitioner resorts to the (unidentified) knowledge of a POSITA.

87. The sensor nodes 121-124, 320-327 are coupled to undercarriage elements 111-114, 312-315 of a railway car 110. Ex. 1006, [0012], [0031]. Each of the undercarriage elements 111-114, 312-315 comprises equipment related to the rolling motion of the railway car 110. Such equipment includes a wheel, axle, gearbox, bearing, bearing box, journal box, trucks or brakes. Ex. 1006, [0013], [0032]. Each sensor node may be attached or coupled to a non-rotating portion of the undercarriage element or a rotating portion of the undercarriage element. Ex.

1006, [0034]. The non-rotating portion can include a bracket or bearing mount.

The rotating portion can include axle, drive shaft, or wheel. *Id.*

88. Each sensor node is configured to sense and report information about the respective undercarriage element. Ex. 1006, [0014]-[0033]. The sensor of the sensor node can include a thermistor, thermometer or an IR emitter/detector to monitor the undercarriage element's temperature. Ex. 1006, [0014], [0025], [0033], [0046]. The measured temperature of the undercarriage element is communicated from the sensor nodes to a control node 130, 330. Ex. 1006, [0027]. The control node 130, 330 can compare the measured temperature to a threshold temperature (e.g., a running average temperatures measured by a population of sensor nodes), and selectively issue an alarm based on the results of the comparison. Ex. 1006, [0027]-[0029]. Armitage does not disclose cross-correlating the temperature of one part to determine the temperature of another part.

89. For similar reasons as those provided above, a POSITA would not look to Armitage's disclosure for determining whether a reading is outside acceptable range of temperatures. First, Armitage discloses dynamically normalized moving average of readings and does not compare a temperature reading to "an acceptable range of temperatures." Ex. 1006, [0029], [0042], [0043]. Secondly, Armitage expressly discloses that a fault condition is determined using a

dynamically determined threshold. Ex. 1006, [0030], [0041]-[0043]. Armitage simply assumes that when a sensor's data is far enough away from the average of all sensor data that the corresponding component may experience a failure. This is insufficient to meet the "acceptable range of temperatures" element, just as it is insufficient to meet the "nominal operating conditions" element of limitation 1(b). *See* ¶¶ 52 *ff.* A POSITA seeking to determine whether a temperature reading is inside or outside of "an acceptable range of temperatures." would not look to Armitage and its disclosure of dynamic thresholds.

90. In support of Petitioner's invalidity argument, Mr. Ricca in his ¶ 106 cites Matzan (Ex. 1018) as a system "for automatic detection of overheated wheel bearings of railroad cars and carriages." I note that Matzan is not one of the references relied on in the Petition in Ground 3. Nevertheless, Matzan contains no disclosure regarding temperature sensing, beyond that of Armitage, which, as explained in this section, is deficient. Further, Matzan does not disclose inferring the temperature of a part by taking the temperature of a different part.

91. Limitation 10(c) recites, "determining if said temperature of the desired part is outside an acceptable range of temperatures." Armitage, as discussed above, does not teach this step. Instead, it simply compares the reading of one sensor with that of other sensors, and that reading may or may not lie outside an acceptable range." Instead, Armitage calculates deviations from a

dynamically normalized moving average of readings and does not compare a temperature reading of one component to “an acceptable range of temperatures.”

92. In my opinion, Petitioner has not established that independent claim 10 is obvious over Armitage. Therefore, Petitioner has not established that claims 11 and 12, which depend from independent claim 10, are obvious.

D. Ground 4: Petitioner has failed to show a reasonable likelihood that Claims 3, 5, 12–18, and 20–22 are obvious over Armitage in view of LeFebvre

1. Claims 3, 5, and 13

93. Claims 3, 5 and 13 depend from claim 1.

94. As shown above, Petitioner has not demonstrated that independent claim 1 is obvious over Armitage. Ground 4 of the Petition does not rely on LeFebvre for any limitation of independent claim 1. Therefore, LeFebvre fails to cure the cited deficiencies in Armitage for this ground, so Petitioner has not established that claims 3, 5, and 13, which depend from independent claim 1, are obvious.

2. Claim 12

95. Claim 12 depends from independent claim 10.

96. As shown above, Petitioner has not demonstrated that independent claim 10 is obvious over Armitage. Ground 4 of the petition does not rely on LeFebvre for any limitation of independent claim 10. Therefore, LeFebvre fails to

cure the cited deficiencies in Armitage for this ground, so Petitioner has not

established that claim 12, which depends from independent claim 10, is obvious.

3. Claim 14

97. Claim 14 is independent.

a. Petitioner has not established a motivation to modify Armitage

98. Petitioner acknowledges that “Armitage does not expressly disclose that its sensor nodes periodically collect sensor readings from the sensor units,” but then alleges that, if Armitage were modified to include digital sensors, the sensors would “inherently transmit data on a periodic basis.” Petition at 73. Neither the Petition nor the Petitioner’s expert establishes an adequate foundation or motivation to modify Armitage to include digital sensors.

99. Further, it is not “inherent” that sensors would “transmit data on a periodic basis.” Sensors, in fact, can transmit data continuously or can transmit only when interrogated.

100. Armitage includes analog to digital converters, so it is unclear why a POSITA would incorporate digital sensors into the Armitage invention. Ex. 1006, 4:67-5:22. The output of the analog sensors in Armitage is converted to digital data, thus completely eliminating the need for digital sensors. Petitioner also does

not explain what other modifications to Armitage would be necessary to include digital temperature sensors. Petition at 73; Ex. 1003, ¶273.

b. Petitioner has not established a motivation to combine Armitage and LeFebvre

101. Petitioner cannot show any motivation to modify Armitage in view of LeFebvre to arrive at claim 14 because doing so would change the basic operating principles of the Armitage invention. Petitioner relies exclusively on LeFebvre's power-saving features to meet limitation 14(a): "wirelessly receiving data from one or more sensing units which periodically collect readings from one or more sensors disposed on said railcar." Petition, 33; Ex. 1005, [0034]-[0035]. The only motivation alleged by Petitioner to make the modification is because "it predictably saves power." Petition, 74. The specification of the '673 patent expressly distinguishes between the power-saving functionality and the periodic collection of data for analysis. Ex. 1001, 5:36-42, 14:11-14. LeFebvre discloses that a sensor goes to sleep "until it has to perform its next tasks," not waking up periodically. A POSITA would appreciate that "periodically" and "until it has to perform its next tasks" are two different concepts.

102. For this invalidity ground, Petitioner relies on a data analysis technique that requires "continuous monitoring" and there is no indication in Armitage that power saving is a concern. Ex. 1006, [0044]. Armitage discloses that

the sensors operate in the conventional manner by continuously performing sensing while the railcar is in motion. Specifically, Armitage analyzes sensor data through a comparison of the data from one sensor to a running average of data from a population of sensors and identifies outliers. Armitage, [0030], [0042].

103. LeFebvre, in contrast, discloses a sensor which “is programmed to switch on briefly” but would normally be “in a low powered state most of the time.” LeFebvre, [0034]-[0035]. Such a modification to Armitage would inhibit the ability of Armitage’s sensor to “continuous[ly] monitor[] all critical railway components.” Armitage, [0044]. Moreover, placing a sensor in a low power standby state is simply not the same thing at all as “periodically collect[ing] readings from one or more sensors” as recited by limitation 14(a). Petitioner has not shown that LeFebvre discloses limitation 14(a) at least because a POSITA would not confuse the periodic collection of readings from one or more sensors with a power management method.

104. Also, a POSITA would not look to combine the dynamic continuous monitoring of Armitage and the power management features of LeFebvre to perform periodic collections of sensor data with any probability of success because the power management features disclosed in LeFebvre would prevent Armitage’s system from establishing an accurate running average of the sensor data. Ex. 1006, [0041]-[0044]. Indeed, a POSITA would not have a high expectation of success in

modifying an invention requiring dynamic comparative analysis of a population of sensor data where the sensors are to switch off most of the time. Thus, LeFebvre's alleged "power-saving scheme" would not motivate a POSITA to modify Armitage in the manner described in the Petition.

105. It is my opinion that Petitioner has failed to establish that a POSITA would find independent claim 14 obvious over Armitage and LeFebvre at least because there is no motivation to modify Armitage in view of LeFebvre. Claims 15-20 depend from independent claim 14 and consequently Petitioner cannot show that they are obvious.

c. **Petitioner does not adequately address how the prior art teaches limitation 14(b)**

106. The disclosure of statistics in Armitage is limited to this single sentence in [0030]: "Statistically significant deviations are derived from a series of sensor data captured over time for one or several members of the population of sensors."

107. Petitioner does not adequately address limitation 14(b), specifically the heuristic determination of an actual or the prediction of a potential or imminent failure or how a "statistical analysis" is applied to the collected data **in conjunction with a heuristic** to make such a prediction. This shortcoming results from Petitioner's application of its claim 1 arguments to claim 14. Petition, 73. The

Petition includes a cross reference to the discussion of limitations 1(b), 1(c), 8(e), and 9(a), but provides no additional factual information that would indicate that a POSITA would view a “fault condition” to be either an “actual failure” or a “potential or imminent failure.” However, none of the referenced limitations include recitations of “actual failure” or “potential or imminent failures.” In any case, Petitioner’s reliance on the discussion of limitation 1(b) is inadequate because the Petition provides no explanation for why a POSITA would consider that limitation applicable to limitation 14(b). Petitioner’s reliance on limitations 1(c), 8(e), and 9(a) are inadequate for the same reason.

4. Claims 21 and 22

108. Claim 21 is independent and includes limitation 21(c): “analyzing said collected data by applying heuristics thereto to (i) determine if an actual failure exists and (ii) to predict potential or imminent failures based on a statistical analysis of said collected data.” Claim 22 depends from claim 21.

109. Petitioner has not established that a POSITA would have been motivated to combine Armitage and LeFebvre to arrive at the claimed use of heuristics to “(i) determine if an actual failure exists and (ii) to predict potential or imminent failures based on a statistical analysis of said collected data.” As explained above in connection with limitations 1(b) and 14(a), incorporating the

power saving scheme of LeFebvre into Armitage would frustrate the basic operating principles of Armitage.”

110. In my opinion, Petitioner has not established that independent claim 21 is obvious over the Armitage-LeFebvre combination. Therefore, Petitioner has not established that Claim 22, which depends from independent claim 21, is obvious.

X. CONCLUDING STATEMENT

111. 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.

112. 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.

113. 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.

Declaration of Michael I. Shamos

U.S. Patent 9,981,673

114. 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 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.

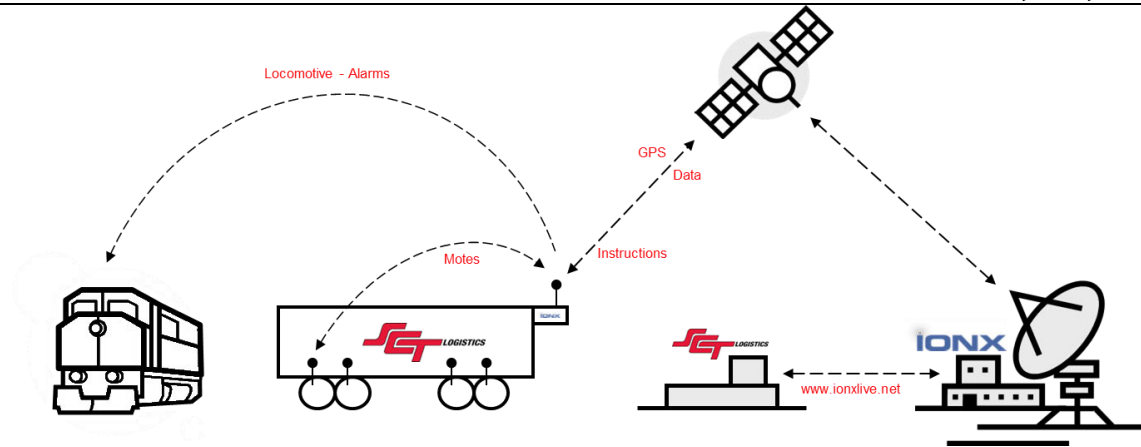
Executed October 19, 2023 at Pittsburgh, PA.


Michael I. Shamos

Appendix A

U.S. Patent No. 9,981,673	Conception
1. A method of monitoring operational characteristics of a railcar comprising the steps of:	The diagram illustrates a railcar monitoring system. On the left, a locomotive is shown. In the center, a railcar with the 'ST LOGISTICS' logo is depicted, equipped with several sensors. A dashed arrow labeled 'Locomotive - Alarms' points from the locomotive to the railcar. Another dashed arrow labeled 'Motes' points from the railcar to a small device on its side. A dashed arrow labeled 'Instructions' points from a ground station to the railcar. A dashed arrow labeled 'GPS Data' points from the railcar to a GPS satellite. The ground station, located on the right, is connected to a network of servers and a large satellite dish. The website 'www.ionxlive.net' is displayed below the ground station. The text 'See Exhibit 2020, dated April 4, 2010; Slide 2.' is written at the bottom of the diagram. See Exhibit 2020, dated April 4, 2010; Slide 2.

a. receiving data or processed information regarding said operational characteristic from one or more sensing units on said railcar, said sensing units monitoring an operational characteristic of said railcar;



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



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

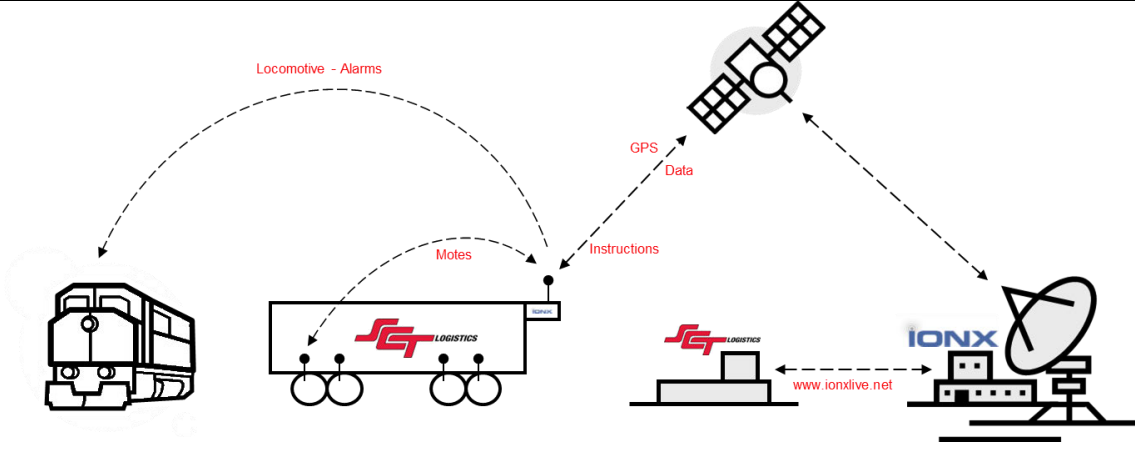
	 “2 bolt attached sensor (for larger bearing end caps)” See Exhibit 2020, dated April 4, 2010; Slide 3.
b. applying a heuristic to said received data to determine deviations from nominal operating conditions;	“ Put simply, prior to the trip we had alarm levels set at temperatures that didn’t take into 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. -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.
c. assigning a severity level to said deviations from nominal operating conditions; and	“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. -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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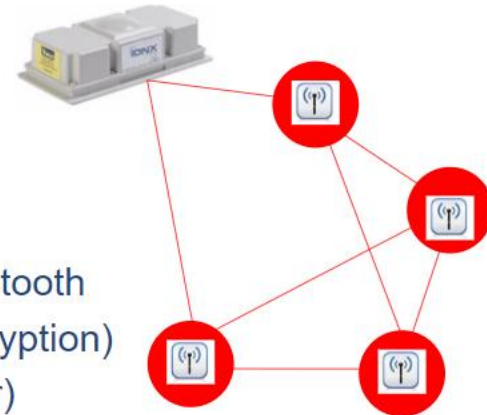
d. determining an alarm condition based on said assigned severity level.	“Stage 1: Bearing Trending -Alarm to IONX only. -Will be removed from locomotive display terminals - Will be used for trending recommendations and repeat offender identifications Stage 2: “Axle Differential Alarm” -Action: Stop 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.
2. The method of claim 1 further comprising the initial step of establishing wireless communication with said one or more remote sensing units.	 See Exhibit 2020, dated April 4, 2010; Slide 2.

3. The method of claim 2 wherein said one or more remote sensing units form a mesh network.

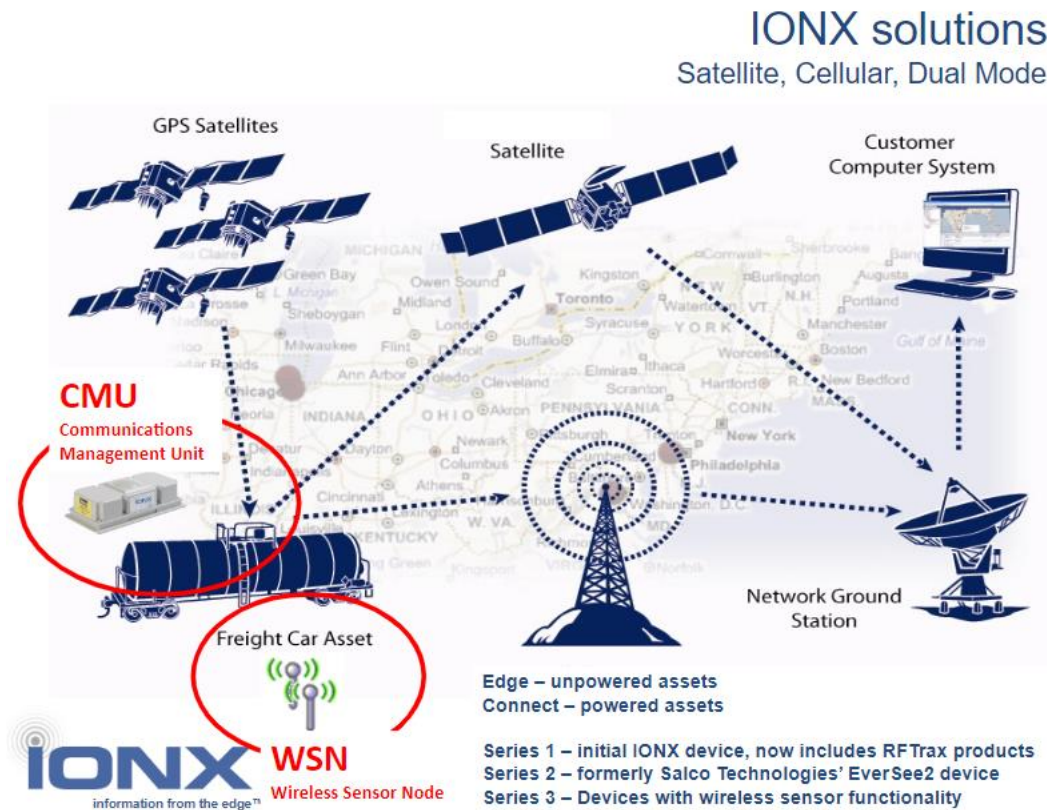
Series 3 - Wireless car-based network

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)

4. The method of claim 2 wherein steps a-d are executed by a processing unit located on said railcar.

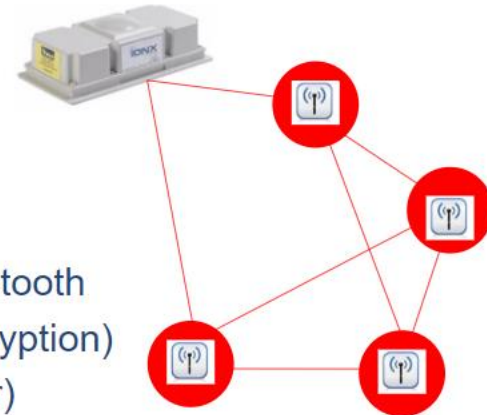


See Exhibit 2017, dated 2010-03-21; slide 5; 2018 (metadata corroborating date)

5. The method of claim 4 wherein said processing unit located on said railcar is a part of said mesh network.

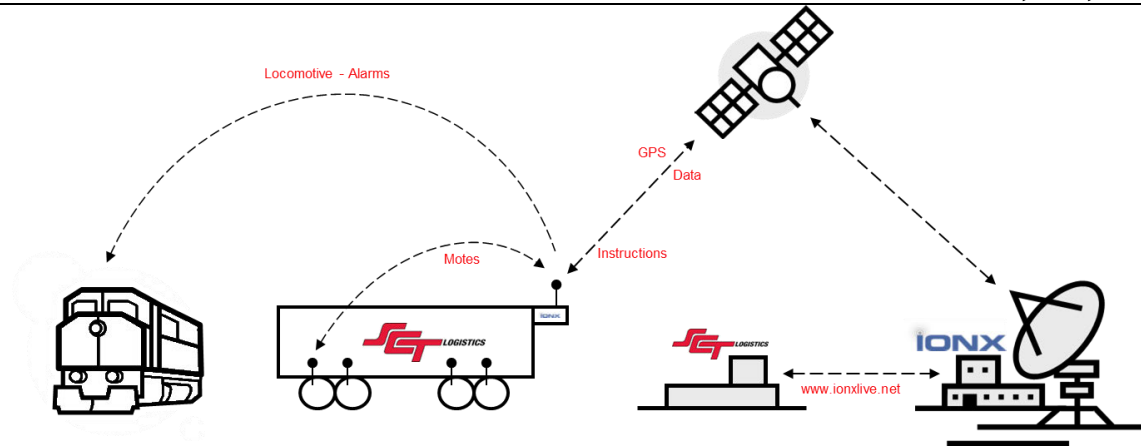
Series 3 - Wireless car-based network

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



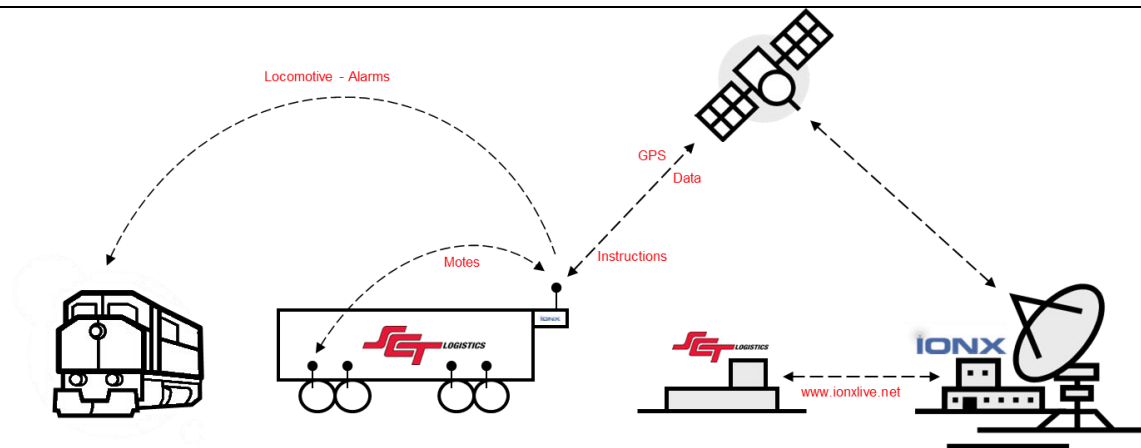
See Exhibit 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

6. The method of claim 2 further comprising the step of transmitting said alarm condition to a location remote from said railcar.

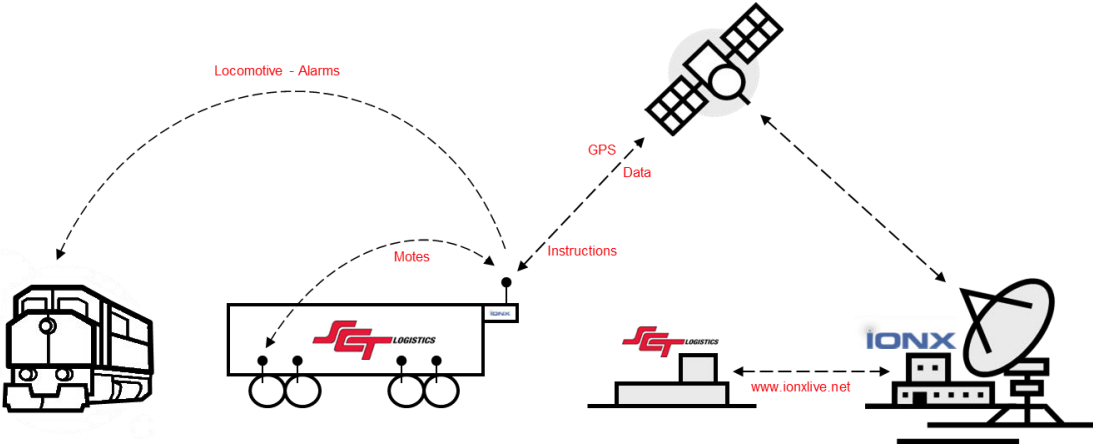


See Exhibit 2020, dated April 4, 2010; Slide 2.

7. The method of claim 2 further comprising the step of transmitting said data received from said one or more sensing units to a location remote from said railcar.



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

8. The method of claim 2 further comprising the steps of:	
a. receiving data from a plurality of railcars;	“we did well, finishing 6/10 cars.... We had to modify the installation on a few of the wagons because the end caps on some of the bearings (SKF and Brenco) did not allow enough clearance for the motes.” Email from Brent Wilson to William Lefebvre and Jay Monaco dated March 25, 2010. Exhibit 2016. (highlighting added).  See Exhibit 2020, dated April 4, 2010; Slide 2.
b. applying a heuristic to said received data to determine deviations from nominal operating conditions;	“Add ‘Critical Bearing Alert’ for website and loco display set to alarm at 320 F above ambient.” See March 31, 2010 email from Andrew Martin (via Brent Wilson’s email address) to inventors and non-inventors. Exhibit 2058.

	“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.
c. assigning a severity level to said deviations from nominal operating conditions;	“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. -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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d. determining an alarm condition based on said assigned severity level;	“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.
e. transmitting said raised alarm to a display unit on a train of which said plurality of railcars are a part.	“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 Inbox F1 F2 F3 F4 F5 F6 1 2ABC 4GHI 5JKL 7PQRS 8TUV * 0 Alert Message Details See Ex 2020, dated April 4, 2010; Slide 7 (highlighting added).
9. The method of claim 6 further comprising the steps of	
a. determining a recommended course of action based on said alarm condition; and	“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. -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.
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	-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 Ex. 2020, dated April 4, 2010; Slide 8.
b. transmitting said recommended course of action to a display unit on a train of which said railcar is a part.	“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.
10. A method of monitoring a temperature of a desired part of a railcar, comprising:	

(a) sensing the temperature of a part of the railcar other than the desired part by use of a temperature sensor in thermal communication with said other part;

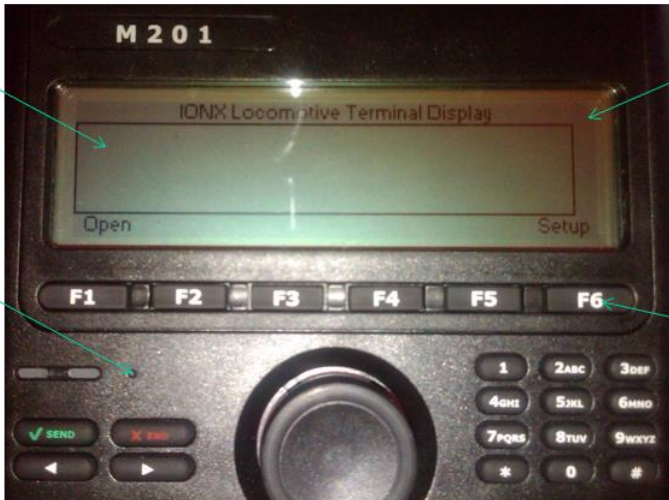


Image shows a wireless temperature sensor mote install, being mechanically attached to a roller bearing adapter, and an ambient sensor mounted under the car body. The wireless temperature sensor mote is configured to determine the temperature of the bearing by measuring the temperature of the bearing adapter.

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

(b) determining the temperature of the desired part by use of the temperature sensed in step (a);	 Image shows a wireless temperature sensor mote install, being mechanically attached to a roller bearing adapter, and an ambient sensor mounted under the car body. The wireless temperature sensor mote is configured to determine the temperature of the bearing by measuring the temperature of the bearing adapter. See Ex. 2020, dated April 4, 2010; Slide 3.
(c) determining if said temperature of the desired part is outside an	“Stage 1: Bearing Trending -Alarm to IONX only.

acceptable range of temperatures; and	-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. -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.
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	-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 Ex. 2020, dated April 4, 2010; Slide 8.
(d) transmitting an alarm if in step (c) it is determined that the temperature of the desired part is outside an acceptable range.	Cab Display  Incoming Alerts will appear here Bright backlight illuminates When alert is received Display will beep when alarm is received Setup Options See Ex. 2020, dated April 4, 2010; Slide 5.

11. A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, further comprising the step of determining the temperature of the ambient air, which temperature is used in the determination of step (b).

“Add ‘Critical Bearing Alert’ for website and loco display set to alarm at 320 F above ambient.”

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



Image shows a wireless temperature sensor mote install, being mechanically attached to a roller bearing adapter, and an ambient sensor mounted under the car body. The wireless temperature sensor mote is configured to determine the temperature of the bearing by measuring the temperature of the bearing adapter.

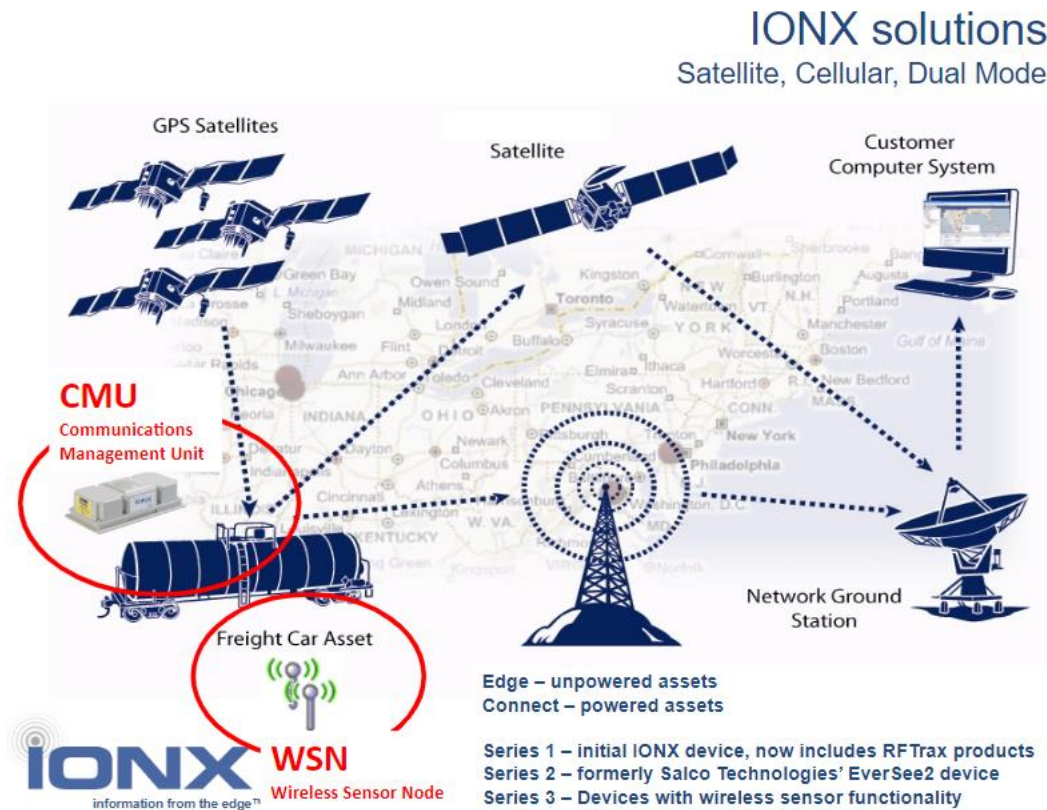
See Ex. 2020, dated April 4, 2010; Slide 3.

12. A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, wherein steps (a) through (d) are carried out by a single unit attached to said railcar.



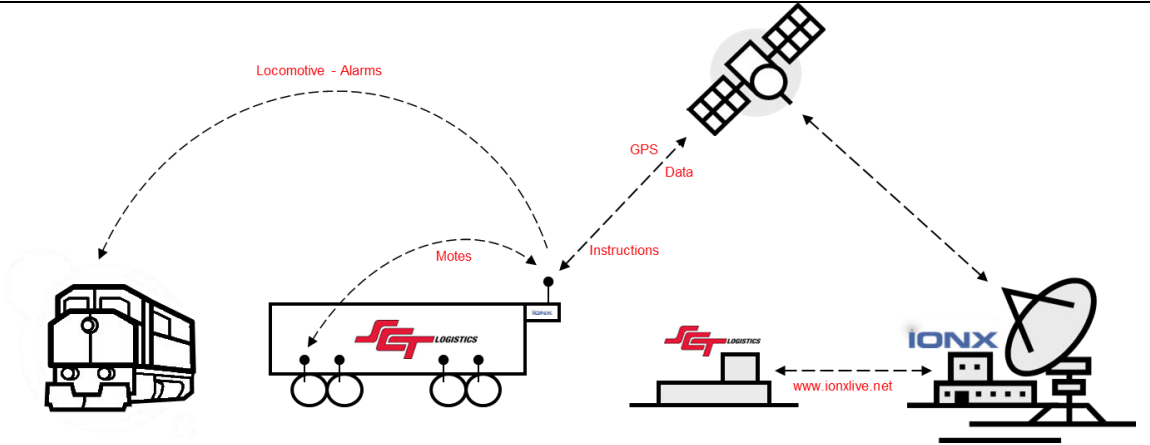
See Exhibit 2017, dated 2010-03-21; slide 8; 2018 (metadata corroborating date)

13. The method of claim 1 wherein steps (a) through (d) can be carried out at different event engines distributed among at least two of said sensor units, a communication management unit, and a mobile or land base station.



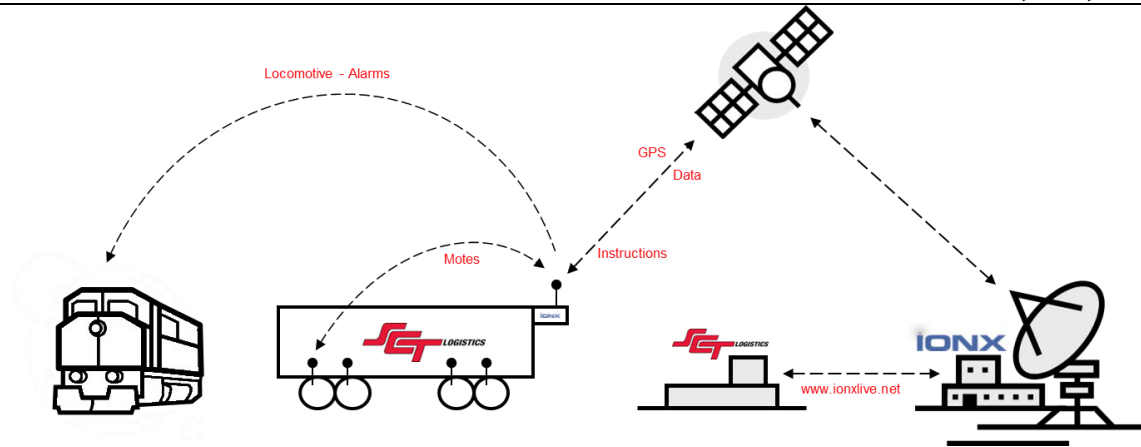
See Exhibit 2017, dated 2010-03-21; slide 5; 2018 (metadata corroborating date)

14. A method for monitoring the operation of a railcar performed by a communication management unit

disposed on said railcar comprising the steps of:	
a. wirelessly receiving data from one or more sensing units which periodically collect readings from one or more sensors disposed on said railcar;	 See Ex. 2020, dated April 4, 2010; Slide 2.
b. heuristically analyzing said received data to determine if an actual failure exists on said railcar or to predict potential or imminent failures based on a statistical analysis of said received data; and	“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. -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 Ex. 2020, dated April 4, 2010; Slide 8.
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c. communicating the results of said analysis to an off-railcar location.



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

15. The method of claim 14 wherein each of said sensing units can make a determination of an alarm condition based on data collected by the sensing unit, said method further comprising the step of:

“Sensor module— wireless – a sensor module that contains a transceiver, microprocessor and one or more sensors that is installed on a railcar. Uses radio frequency to monitor and report a specific actions relating to status or conditions such as vertical force, door position, temperature, etc.”

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)

“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. -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.
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	-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 Ex. 2020, dated April 4, 2010; Slide 8.
a. wirelessly receiving notice of said alarm condition from said sensing unit; and	“Mote – a sensor node that contains a transceiver, microprocessor and one or more sensors. It can send messages to and from the CMU relating to conditions such as vertical force or temperature.... Over-the-air (OTA) programming – the ability to transmit commands to the CMU in order to change settings without having to physically touch the asset.... 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.... Sensor module– wireless – a sensor module that contains a transceiver, microprocessor and one or more sensors that is installed on a railcar. Uses radio frequency to monitor and report a specific actions relating to status or conditions such as vertical force, door position, temperature, etc.”

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)

Cab Display

Incoming Alerts will appear here

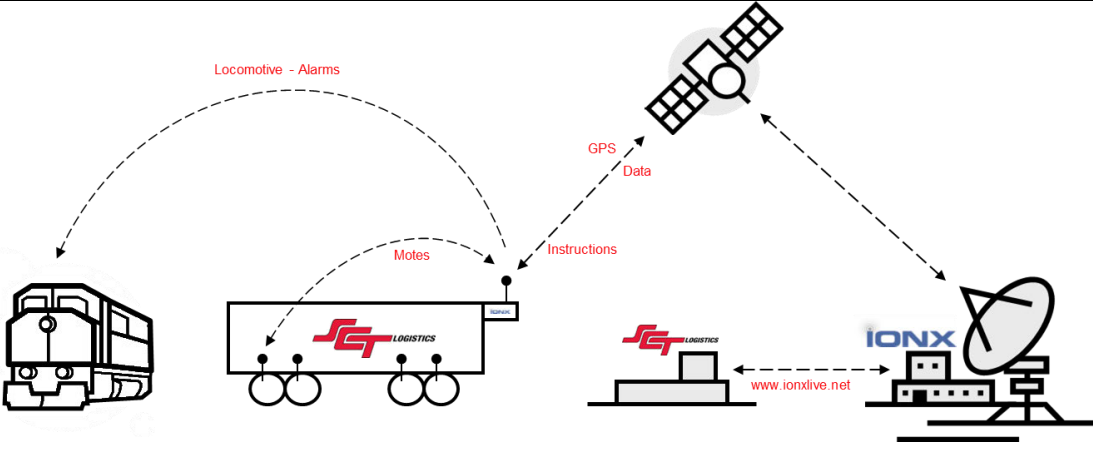
Display will beep when alarm is received



Bright backlight illuminates When alert is received

Setup Options

See Exhibit 2020, dated April 4, 2010; Slide 5.

b. communicating said alarm condition to an off-railcar location.	 See Exhibit 2020, dated April 4, 2010; Slide 2.3.
16. The method of claim 14 further comprising the steps of:	
a. making a determination of an alarm condition based on data received from two or more of said sensing units; and	“Add ‘Critical Bearing Alert’ for website and loco display set to alarm at 320 F above ambient.” See March 31, 2010 email from Andrew Martin (via Brent Wilson’s email address) to inventors and non-inventors. Ex. 2058.

Cab Display

Incoming
Alerts will
appear here

Display will
beep when
alarm is
received

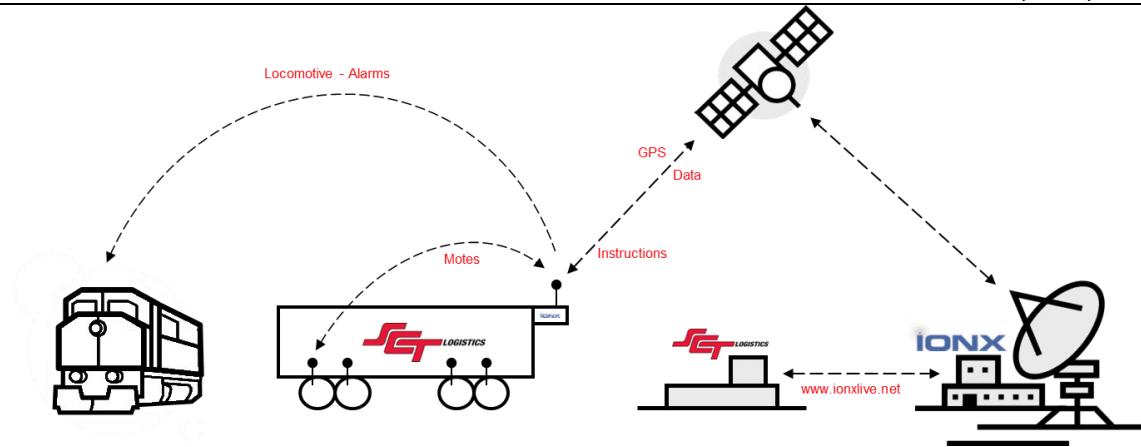


Bright backlight
illuminates
When alert is
received

Setup
Options

See Exhibit 2020, dated April 4, 2010; Slide 5.

b. communicating said alarm condition to an off-railcar location.



See Exhibit 2020, dated April 4, 2010; Slide 2.3.

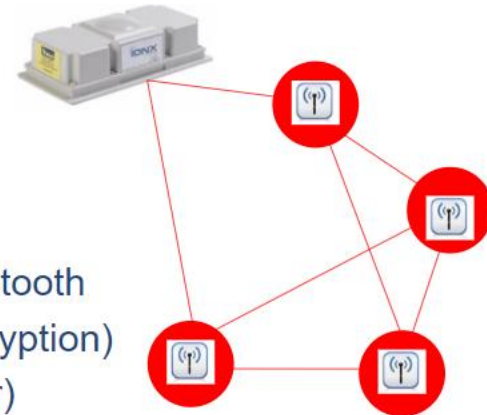
17. The method of claim 14 further comprising the step of placing said one or more sensing units in a stand-by state when said one or more sensing units is not reading data from any of said sensors or transmitting data.

“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)

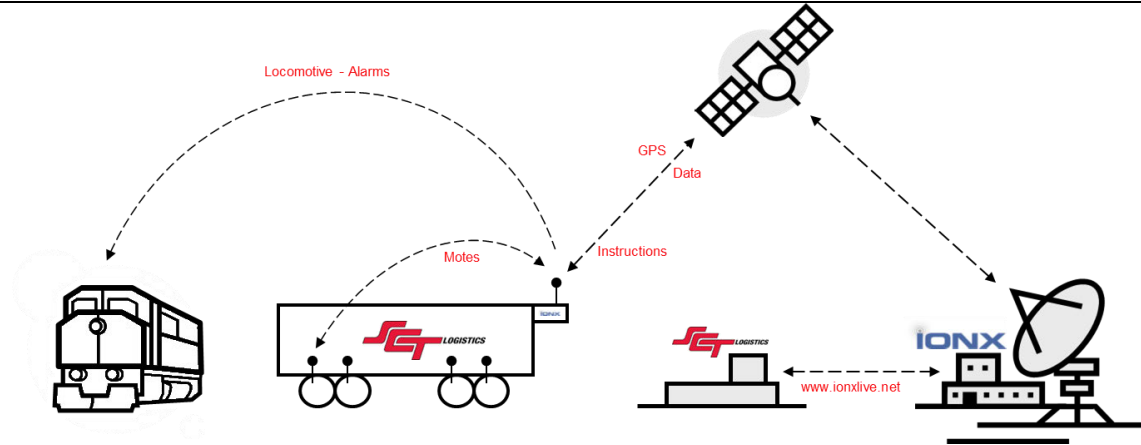
Series 3 - Wireless car-based network

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)

18. The method of claim 14 further comprising the step of joining a mesh network consisting of one or more sensing units located on said railcar.



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



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



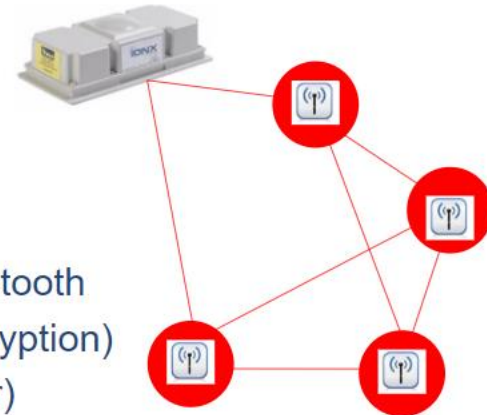
“2 bolt attached sensor (for larger bearing end caps)”

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

19. The method of claim 14 further comprising the step of joining a mesh network consisting of communication management units located on other railcars.

Series 3 - Wireless car-based network

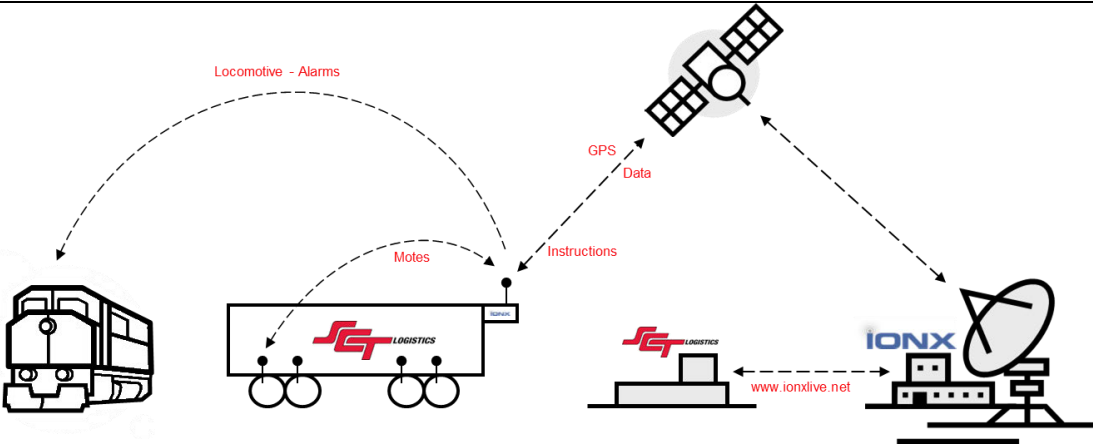
Radio off most of time
Redundant paths (mesh)
Scalable
Frequency Agile
Coexistence with Wi-Fi & Bluetooth
Secure (access control & encryption)
Intelligent routing (node power)



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

20. The system of claim 14 further comprising the steps of:

a. saving data received from said one or more sensing units in memory; and	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)
b. comparing data received with said saved data to identify trends or	“....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

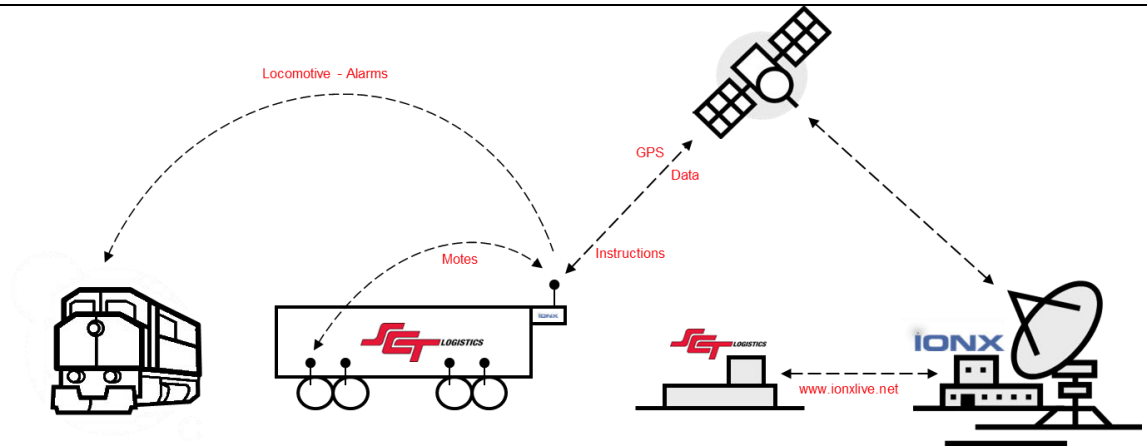
deviations from normal readings of said data stored in memory.	alarm thresholds at values that are sub-critical will lead to too many stoppages and delays along the single-track route to or from Perth. As such, we are recommending for your input revised threshold values so that only actionable messages 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.
21. A method for monitoring the operation of a railcar comprising:	
a. collecting data at periodic intervals about one or more operating parameters of said railcar using one or more sensor units provided on said railcar;	 See Ex. 2020, dated April 4, 2010; Slide 2. See Exhibit 2020, dated April 4, 2010; Slide 2.



“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.
b. communicating said collected data to a communication management unit;	 The diagram illustrates a rail communication system. On the left, a locomotive is shown. In the center, a freight car with the 'JST LOGISTICS' logo is depicted, equipped with a communication unit. Above the freight car, a dashed arrow labeled 'Motes' points to the communication unit. To the right of the freight car, a dashed arrow labeled 'Instructions' points from the communication unit to a satellite. Another dashed arrow labeled 'GPS Data' points from the satellite to the communication unit. A long dashed arrow labeled 'Locomotive - Alarms' points from the locomotive to the communication unit. On the far right, a ground station with a large parabolic dish is shown. A dashed arrow points from the satellite to the ground station. Below the ground station, the text 'www.ionlive.net' is visible. The ground station also has the 'IONX' logo. Exhibit 2020, dated April 4, 2010; Slide 2.

	Sensing Opportunity – Need for Wireless  See Exhibit 2017, dated 2010-03-21; slide 8; 2018 (metadata corroborating date)
c. analyzing said collected data by applying heuristics thereto to (i) determine if an actual failure exists and (ii) to predict potential or	“Stage 1: Bearing Trending -Alarm to IONX only.

imminent failures based on a statistical analysis of said collected data.	-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. -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.
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	-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 method of claim 21 further comprising the steps of:	
assessing the collected data to determine if an alarm condition exists; and wirelessly communicating said alarm condition to an off railcar location.	“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. -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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Appendix B

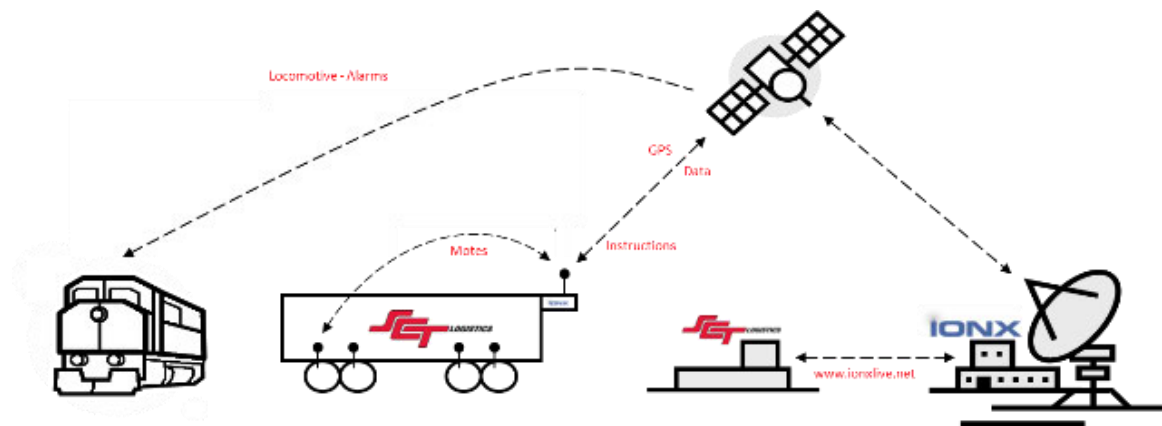
U.S. Patent No. 9,981,673	Reduction to Practice
1. A method of monitoring operational characteristics of a railcar comprising the steps of:	“Objectives: Pilot Project <i>Assess the technical & commercial viability of IONX wireless monitoring solution for bearing condition and performance on SCT Logistics 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. “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.

a. receiving data or processed information regarding said operational characteristic from one or more sensing units on said railcar, said sensing units monitoring an operational characteristic of said railcar;

“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.

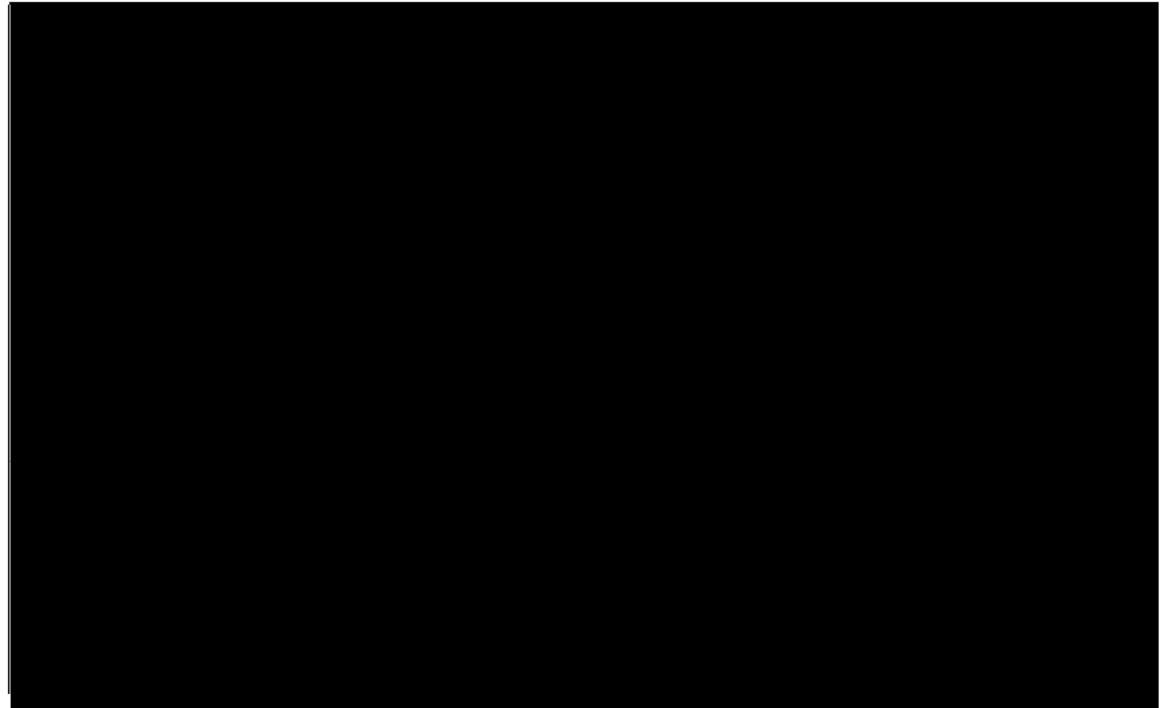
“Progress and Milestones

	• 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”  See Exhibit 2154, dated August 2, 2011; Slide 4.
b. applying a heuristic to said received data to determine deviations from nominal operating conditions;	“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. “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 Ex. 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 Exs. 2013 at ¶18, 2031, 2033.
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c. assigning a severity level to said deviations from nominal operating conditions; and

Alert Instructions



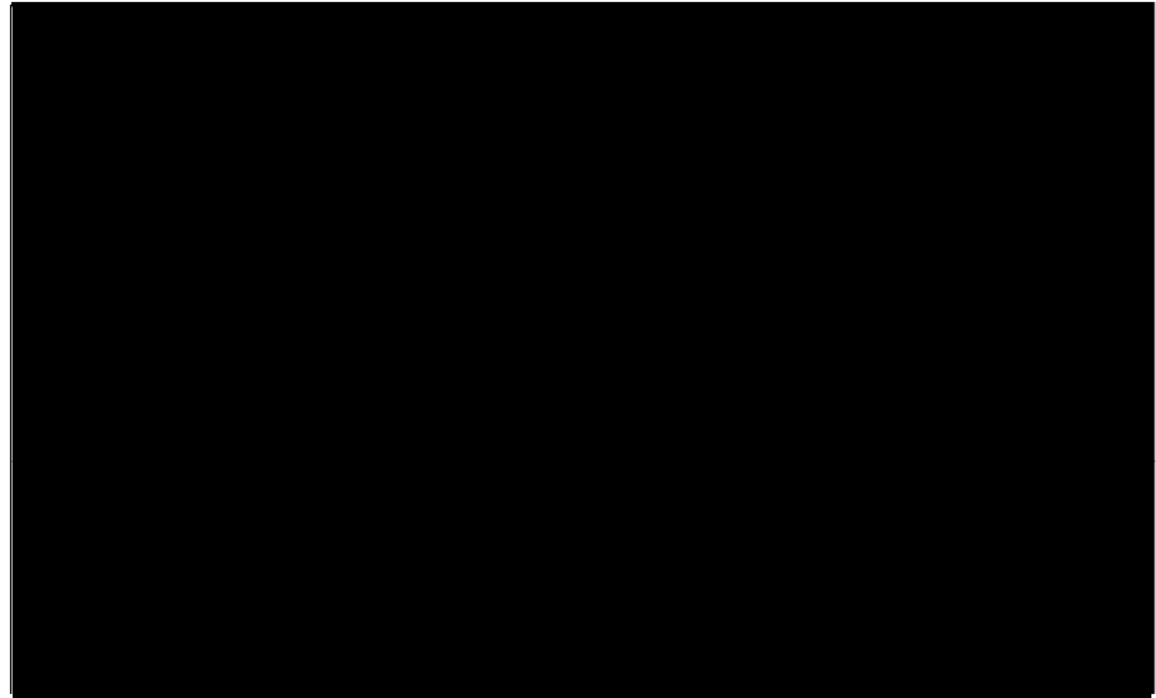
See Exhibit 2022, dated April 8, 2010; Slide 10

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

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

d. determining an alarm condition based on said assigned severity level.

Alert Instructions



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

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

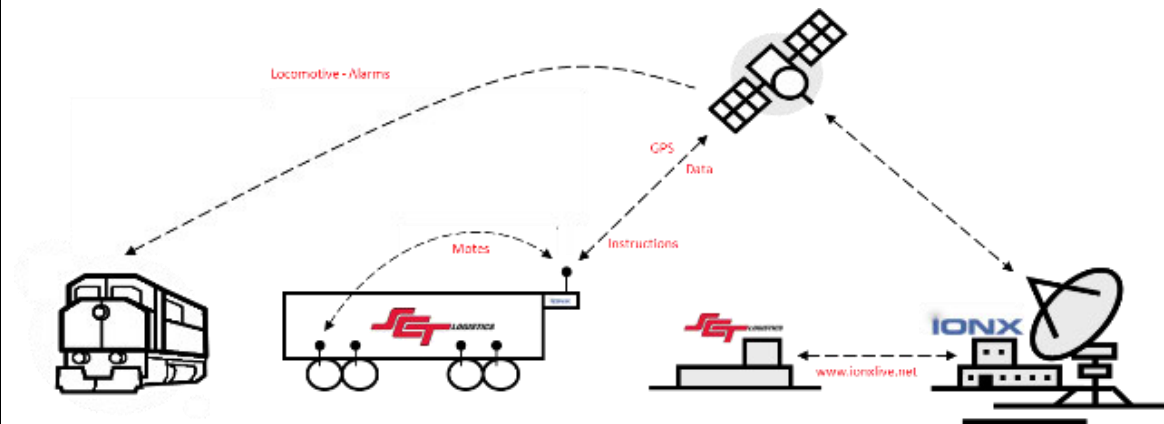
See Exhibit 2154, dated August 2, 2011; Slide 3.

2. The method of claim 1 further comprising the initial step of establishing wireless communication with said one or more remote sensing 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.

“Progress and Milestones

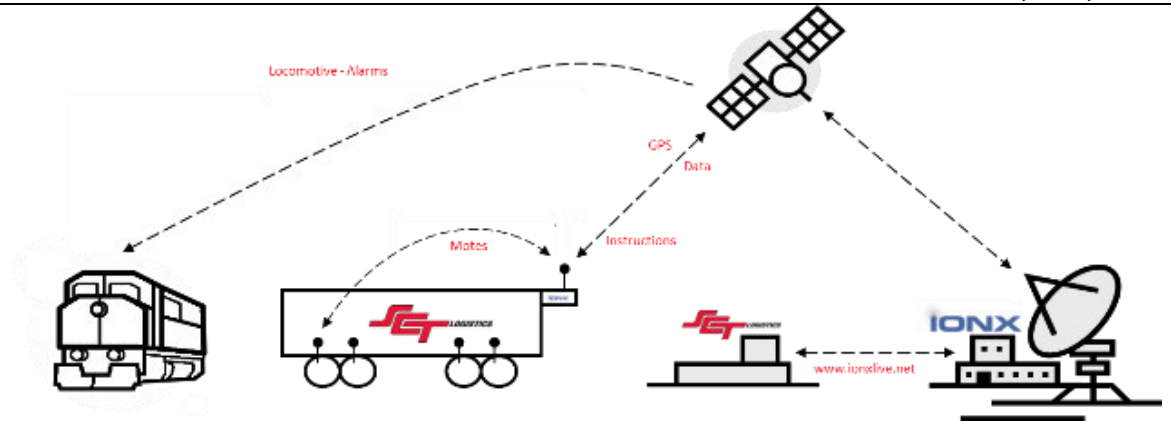
- Installed on ten wagons with more than sixteen months of service

- Over 18 million temperature readings collected to date
- Over 8.5 million kilometers of freight mileage monitored”

See CTRL00091967.0001, dated August 2, 2011; Slide 4.



	Image shows a wireless temperature sensor mote install, being mechanically attached to a roller bearing adapter, and an ambient sensor mounted under the car body. See Exhibit 2154, dated August 2, 2011; Slide 4.
3. The method of claim 2 wherein said one or more remote sensing units form a mesh network.	“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.

“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”

See CTRL00091967.0001, dated August 2, 2011; Slide 4.

Text file with SIM numbers that correspond to each railcar.

See Exs. 2013 at ¶18, 2031, 2033.

4. The method of claim 2 wherein steps a-d are executed by a

“Progress and Milestones

processing unit located on said railcar.

- 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”



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

“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.
5. The method of claim 4 wherein said processing unit located on said railcar is a part of said mesh network.	“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” 

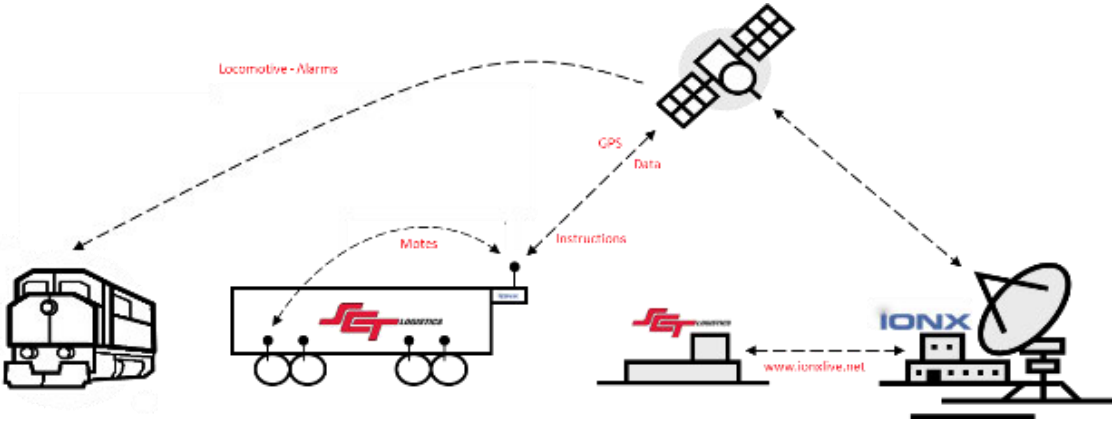


See Exhibit 2154, dated August 2, 2011; Slide 4.

“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. Text file with SIM numbers that correspond to each railcar. See Exs. 2013 at ¶18, 2031, 2033.
6. The method of claim 2 further comprising the step of transmitting	“Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm’s severity. Each alarm level is associated

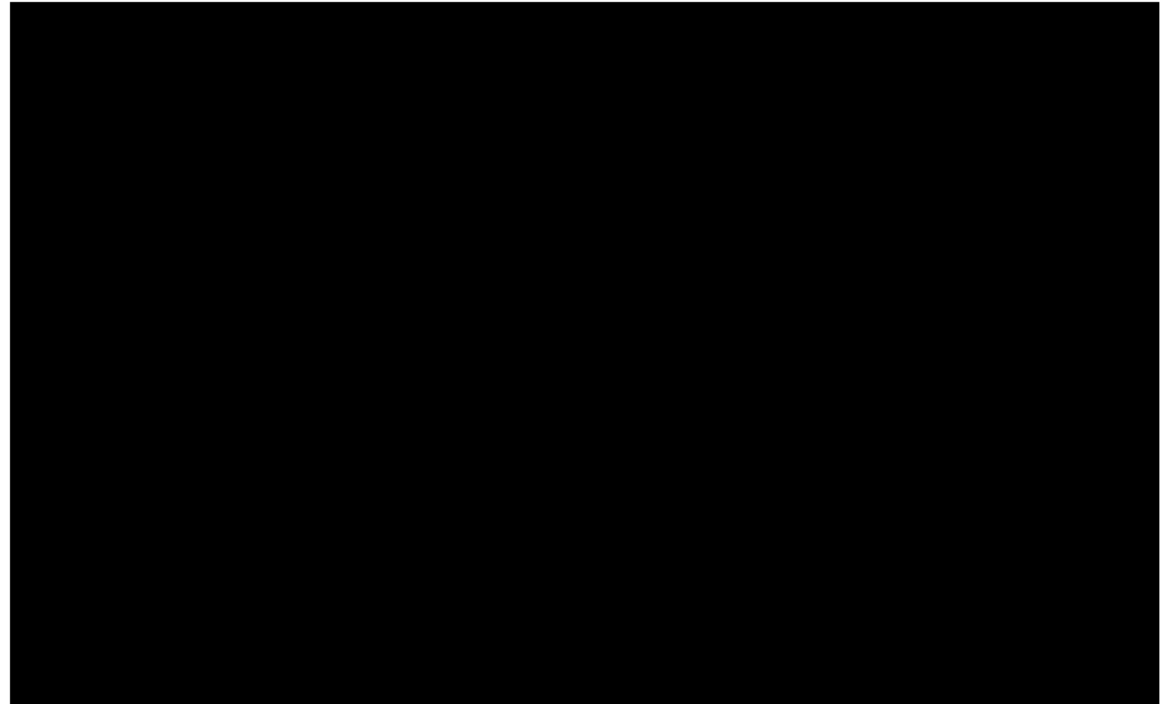
said alarm condition to a location remote from said railcar.	with specific response guidelines for the locomotive's crew, which can involve stopping the train in the most severe cases" See Exhibit 2154, dated August 2, 2011; Slide 5.
7. The method of claim 2 further comprising the step of transmitting said data received from said one or more sensing units to a location remote from 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” 

	See Exhibit 2154, dated August 2, 2011; Slide 3. “... just two algorithms will need to send Temperature Average, Number of samples, and Standard Deviation every 6 hours to the CMU.” See Exhibit 2152.
8. The method of claim 2 further comprising the steps of:	
a. receiving data from a plurality of railcars;	• “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” See Exhibit 2154, dated August 2, 2011; Slide 4.
b. applying a heuristic to said received data to determine deviations from nominal operating conditions;	“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. “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 Ex. 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 Exs. 2013 at ¶18, 2031, 2033.
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c. assigning a severity level to said deviations from nominal operating conditions;

Alert Instructions



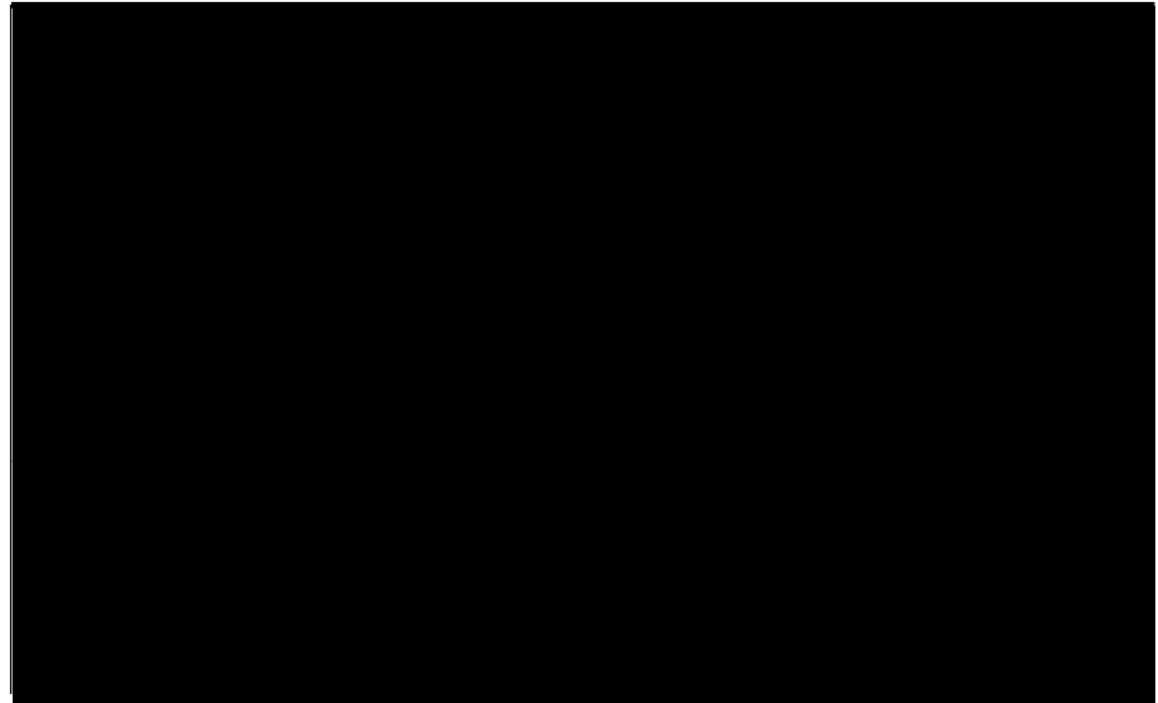
See Exhibit 2022, dated April 8, 2010; Slide 10

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

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

d. determining an alarm condition based on said assigned severity level;

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.

e. transmitting said raised alarm to a display unit on a train of which said plurality of railcars are 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” 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. • 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”
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See Exhibit 2154, dated August 2, 2011; Slide 5.

“All 10 wagons upgrade to new production CMU-T5X •& new WSNs”

See Exhibit 2154, dated August 2, 2011; Slide 12.

9. The method of claim 6 further comprising the steps of

a. determining a recommended course of action based on said alarm condition; and

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.

b. transmitting said recommended course of action to a display unit on a train of which said railcar is a part.

“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.
10. A method of monitoring a temperature of a desired part of a railcar, comprising:	

(a) sensing the temperature of a part of the railcar other than the desired part by use of a temperature sensor in thermal communication with said other part;



Image shows a wireless temperature sensor mote install, being mechanically attached to a roller bearing adapter, and an ambient sensor mounted under the car body. The wireless temperature sensor mote is configured to determine the temperature of the bearing by measuring the temperature of the bearing adapter.

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

(b) determining the temperature of the desired part by use of the temperature sensed in step (a);

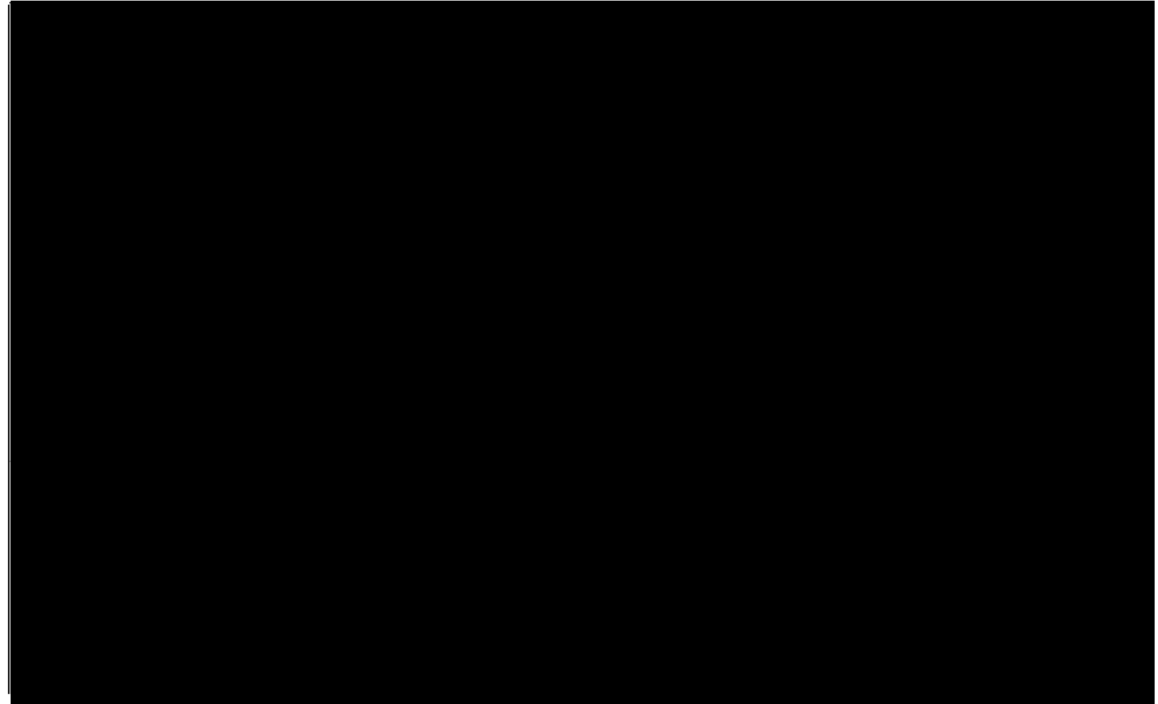


Image shows a wireless temperature sensor mote install, being mechanically attached to a roller bearing adapter, and an ambient sensor mounted under the car body. The wireless temperature sensor mote is configured to determine the temperature of the bearing by measuring the temperature of the bearing adapter.

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

(c) determining if said temperature of the desired part is outside an acceptable range of temperatures; and

Alert Instructions



See 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.

(d) transmitting an alarm if in step (c) it is determined that the temperature of the desired part is outside an acceptable range.	“Create actionable alarms for “hot” bearings – including locomotive alert system” 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. • 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”
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See Exhibit 2154, dated August 2, 2011; Slide 5.

Alert Instructions

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

11. A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, further comprising the step of determining the temperature of the ambient air, which temperature is used in the determination of step (b).



Image shows a wireless temperature sensor mote install, being mechanically attached to a roller bearing adapter, and an ambient sensor mounted under the car body. .

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

	““Based on my calculation. If the ambient temp is below 65F. Than stage 3 alarm will trigger before stage 2.” See Ex. 2024
12. A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, wherein steps (a) through (d) are carried out by a single unit attached to said railcar.	“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” 



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

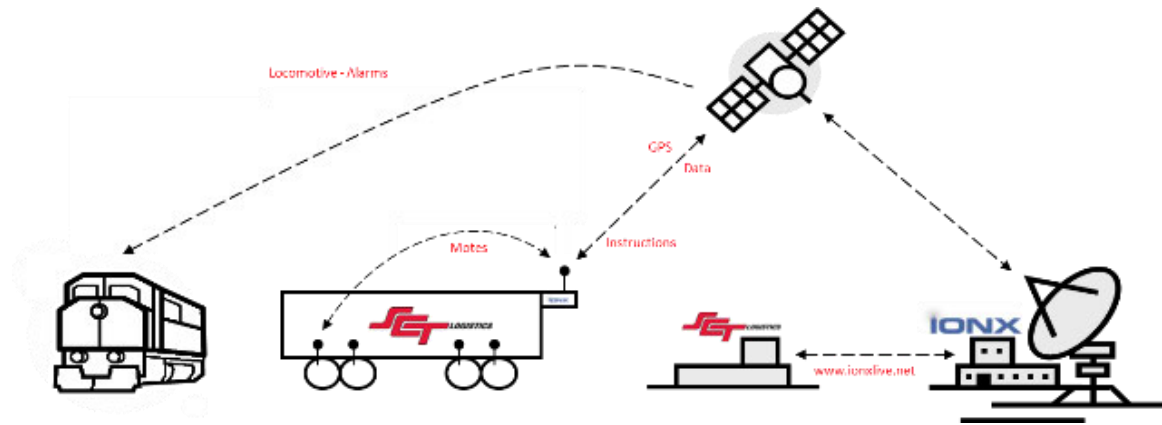
“Actionable alarms for “hot” bearings

- 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.
13. The method of claim 1 wherein steps (a) through (d) can be carried out at different event engines distributed among at least two of said sensor units, a communication	“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

management unit, and a mobile or land base station.

- 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.

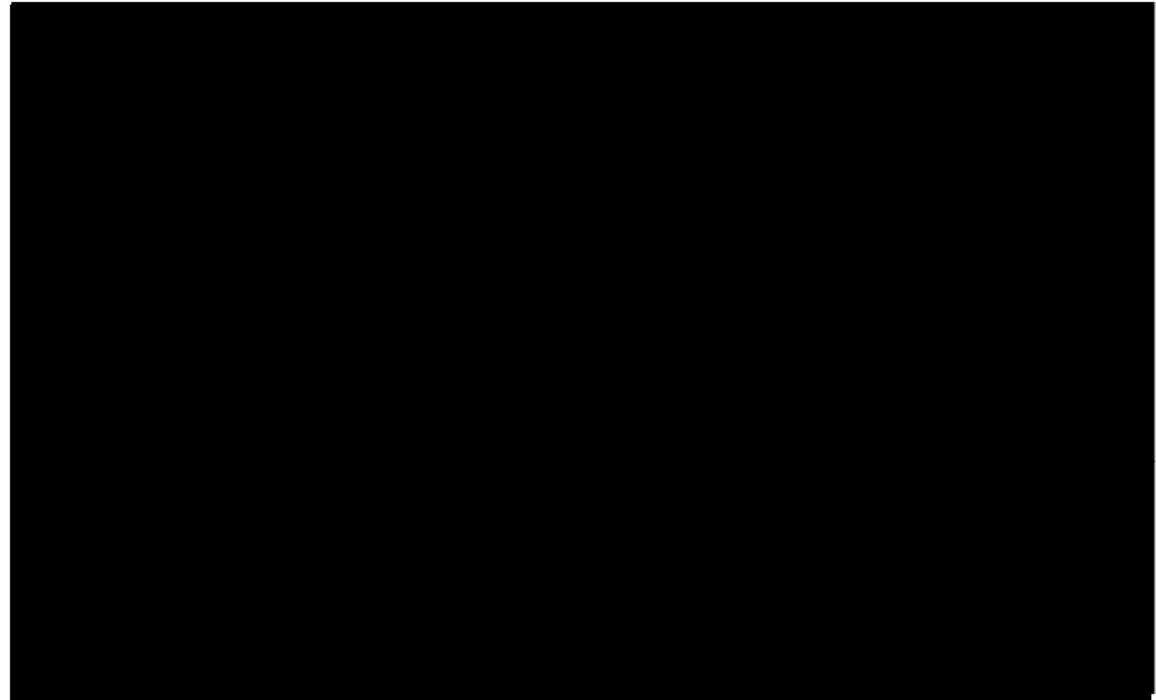
“Progress and Milestones

- 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”



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

Alert Instructions



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

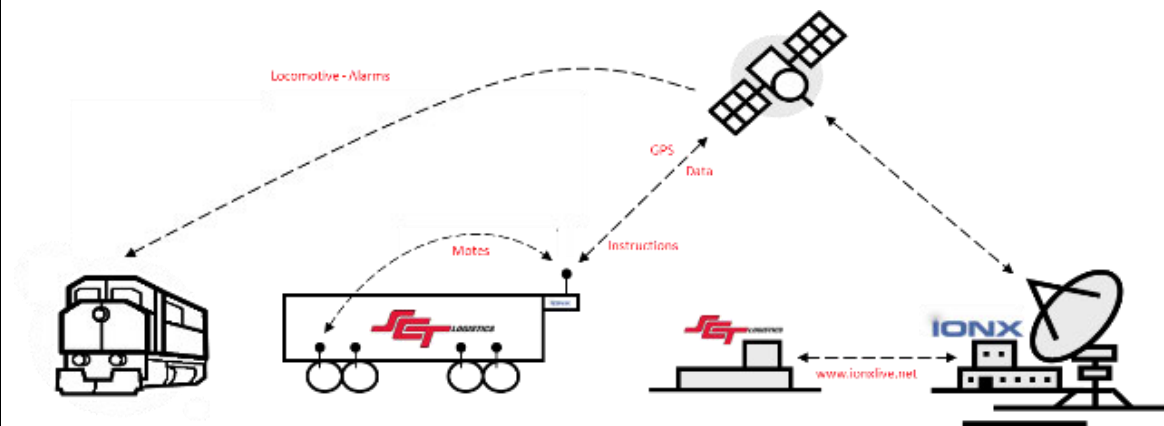
14. A method for monitoring the operation of a railcar performed by a communication management unit disposed on said railcar comprising the steps of:

a. wirelessly receiving data from one or more sensing units which periodically collect readings from one or more sensors disposed on 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.

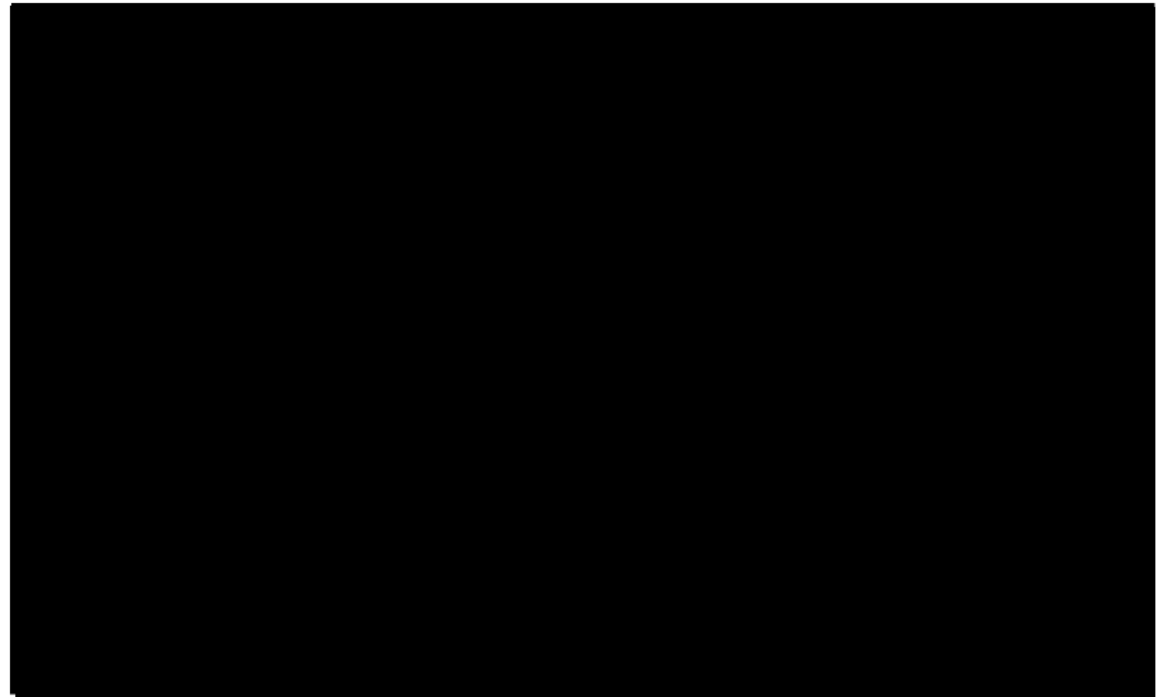
“Progress and Milestones

	• 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”  See Exhibit 2154, dated August 2, 2011; Slide 4. “Andoni has configured one WSN to report temperature readings every 15 seconds” See Exhibit 2151, dated July 19, 2011, at 19.
b. heuristically analyzing said received data to determine if an actual failure exists on said railcar or to predict potential or imminent	“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”

failures based on a statistical
analysis of said received data; and

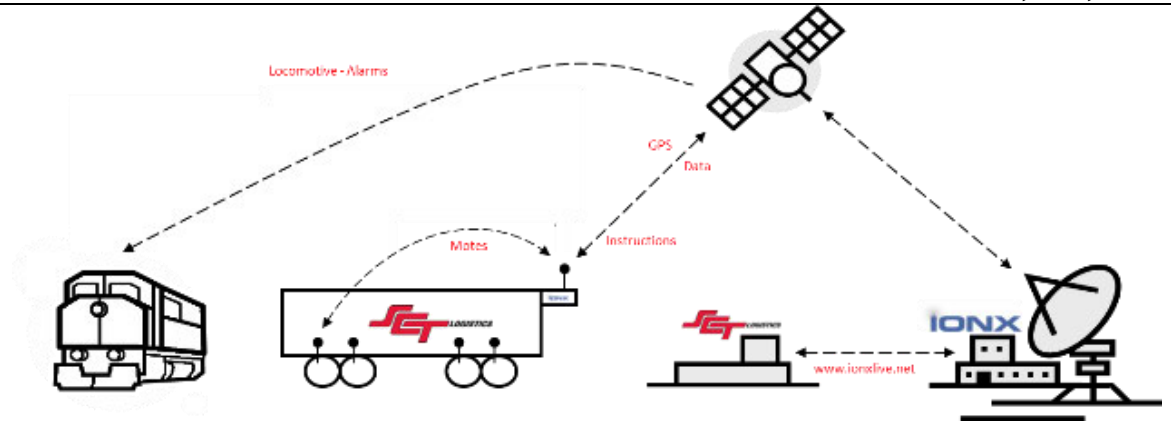
See Exhibit 2154, dated August 2, 2011; Slide 13.

Alert Instructions



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

c. communicating the results of said analysis to an off-railcar location.



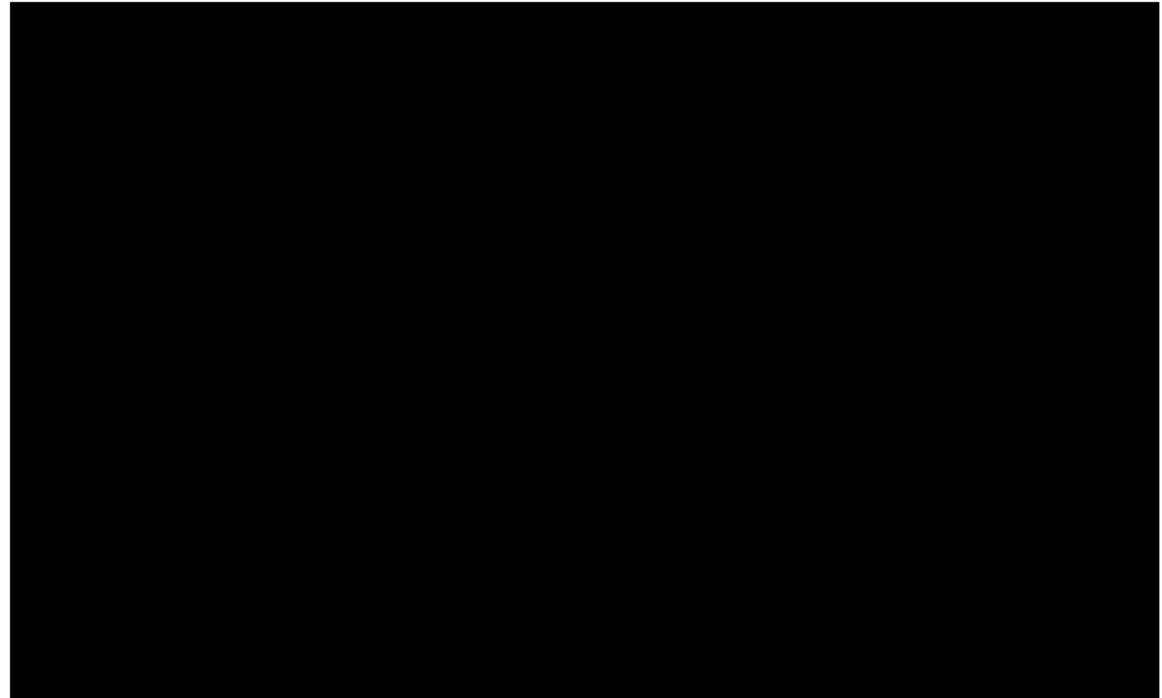
See Exhibit 2154, dated August 2, 2011; Slide 3.

“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.

15. The method of claim 14 wherein each of said sensing units can make a determination of an alarm condition based on data collected by the sensing unit, said method further comprising the step of:

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.

a. wirelessly receiving notice of said alarm condition from said sensing unit; and

“Actionable alarms for “hot” bearings

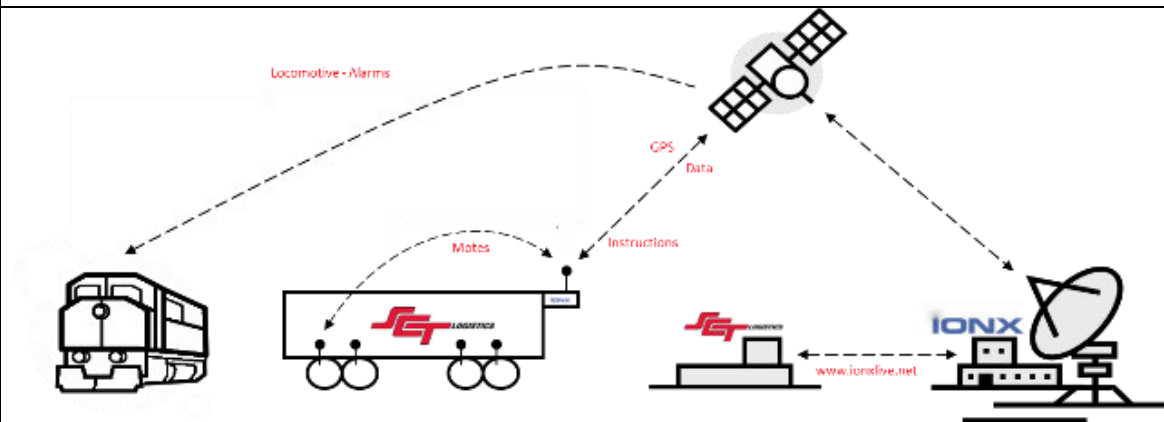
- Alarms are generated by the WSN or CMU and relayed to the terminal in the locomotive via satellite. Dynamic geo-fence around the locomotive associates wagons with alarms to a train manifest.
- Each alarm is communicated to IONX and/or directly to the locomotive display, depending on the alarm’s severity. 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.

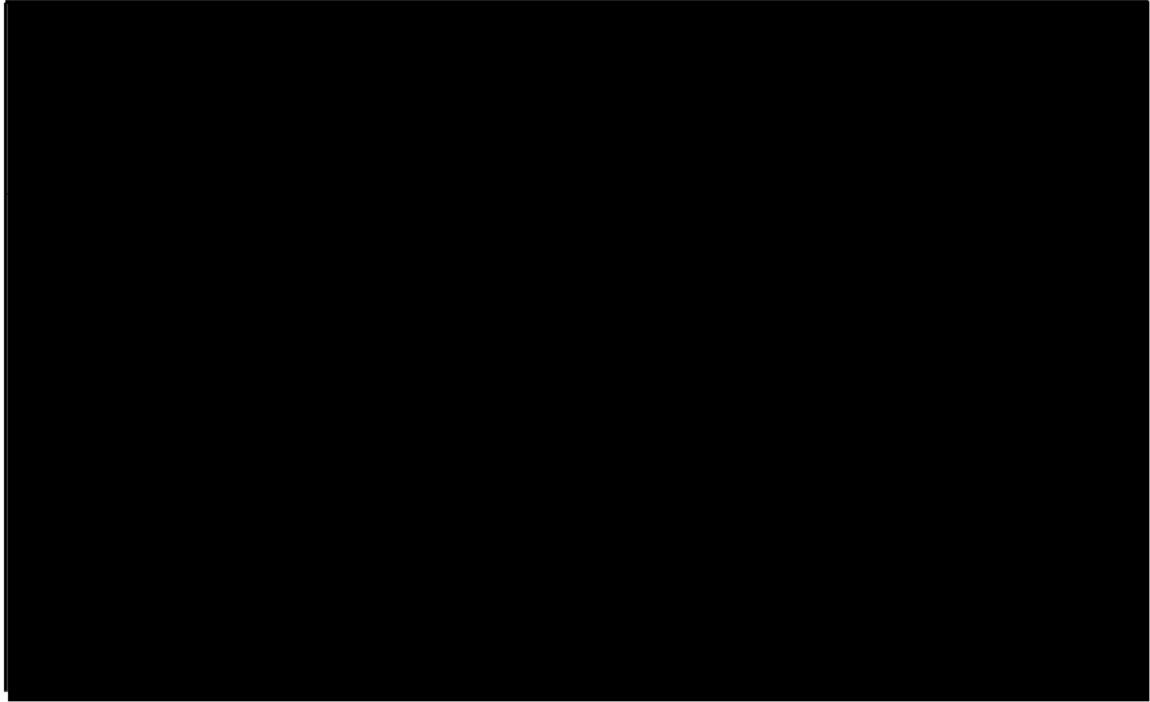
b. communicating said alarm condition to an off-railcar location.

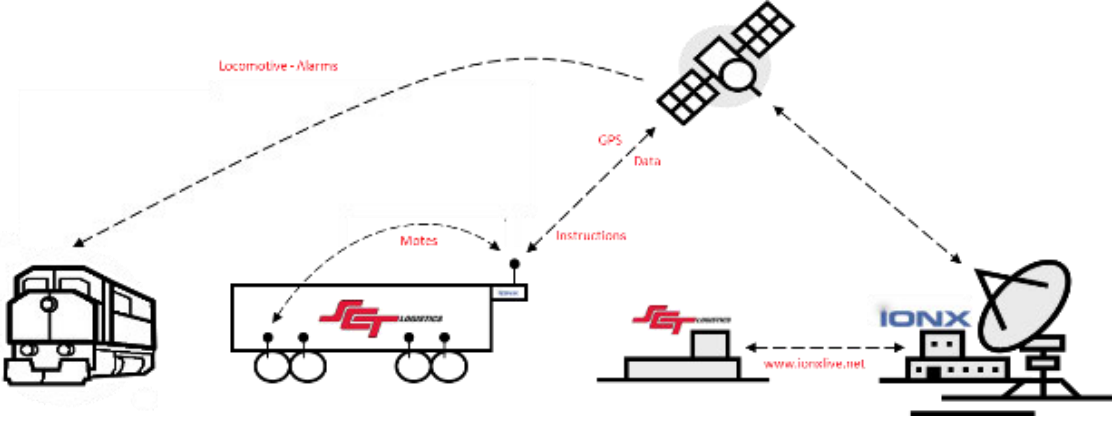


See Exhibit 2154, dated August 2, 2011; Slide 3.

“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.

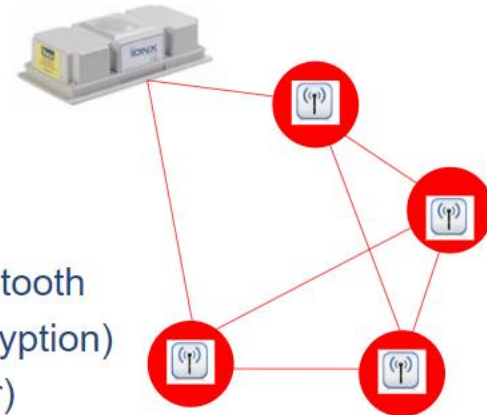
16. The method of claim 14 further comprising the steps of:	
a. making a determination of an alarm condition based on data received from two or more of said sensing units; and	Alert Instructions  See Exhibit 2022, dated April 8, 2010; Slide 10 “Create actionable alarms for “hot” bearings – including locomotive alert system”

	See Exhibit 2154, dated August 2, 2011; Slide 3. “Criteria 3 & 4 Deviation from Car/Fleet Average • These criteria require temperature readings from all bearings on a car (or all bearings in the fleet) for comparison with a single bearings temperature history. • The car/fleet's average temperature and standard deviation are compared to one bearing's average operating temperature to determine the number of standard deviations between the two.” See Exhibit 2151, dated July 19, 2011, at 16.
b. communicating said alarm condition to an off-railcar location.	 See Exhibit 2154, dated August 2, 2011; Slide 3.

	“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.
17. The method of claim 14 further comprising the step of placing said one or more sensing units in a stand-by state when said one or more sensing units is not reading data from any of said sensors or transmitting data.	“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)

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)



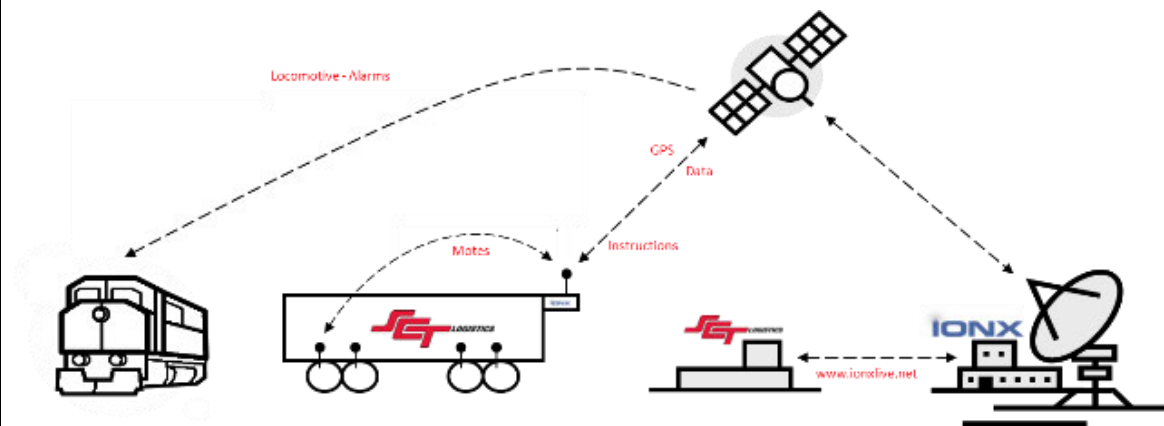
See Exhibits 2017, dated 2010-03-21; slide 9; 2018 (metadata corroborating date)

18. The method of claim 14 further comprising the step of joining a mesh network consisting of one or more sensing units located on 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”



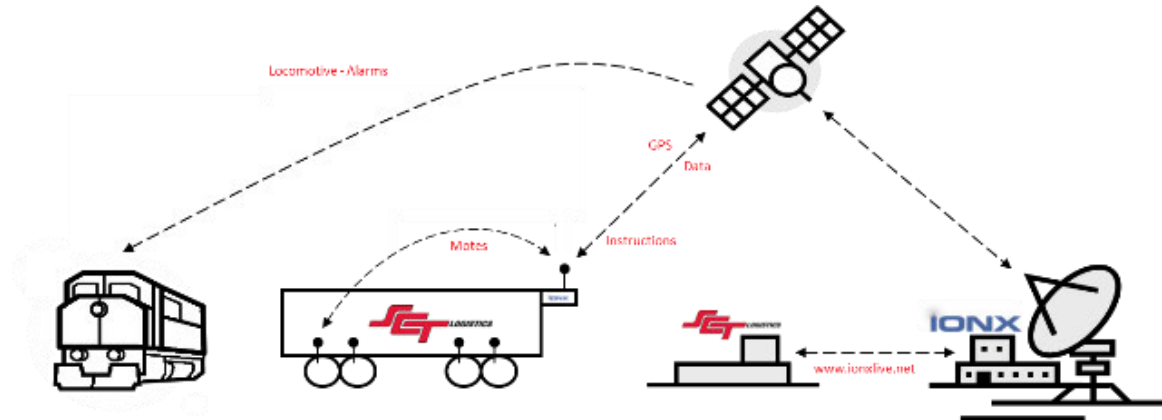
See Exhibit 2154, dated August 2, 2011; Slide 3.

“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” See Exhibit 2154, dated August 2, 2011; Slide 4. “Criteria 3 & 4 Deviation from Car/Fleet Average • These criteria require temperature readings from all bearings on a car (or all bearings in the fleet) for comparison with a single bearings temperature history. • The car/fleet's average temperature and standard deviation are compared to one bearing's average operating temperature to determine the number of standard deviations between the two.” See Exhibit 2151, dated July 19, 2011, at 16.
19. The method of claim 14 further comprising the step of joining a mesh network consisting of communication management units located on other railcars.	“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.

“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”

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

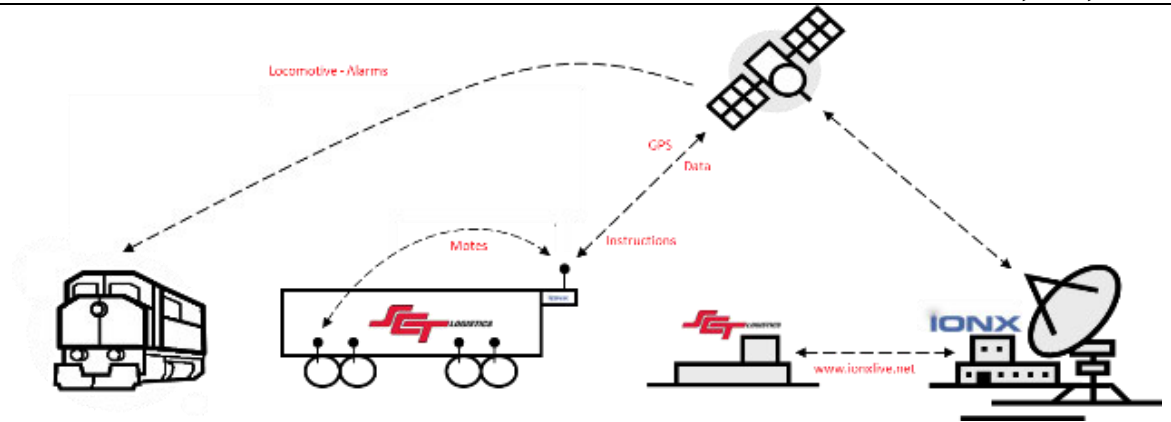
Text file with SIM numbers that correspond to each railcar.

See Exs. 2013 at ¶18, 2031, 2033.

“Criteria 3 & 4

	Deviation from Car/Fleet Average • These criteria require temperature readings from all bearings on a car (or all bearings in the fleet) for comparison with a single bearings temperature history. • The car/fleet's average temperature and standard deviation are compared to one bearing's average operating temperature to determine the number of standard deviations between the two.” See Exhibit 2151, dated July 19, 2011, at 16.
20. The system of claim 14 further comprising the steps of:	
a. saving data received from said one or more sensing units in memory; and	“Collect data to validate algorithms that indicate bearing “condition”” See Exhibit 2154, dated August 2, 2011; Slide 3. “Over 18 million temperature readings collected to date” See Exhibit 2154, dated August 2, 2011; Slide 4.
b. comparing data received with said saved data to identify trends or deviations from normal readings of said data stored in memory.	“Collect data to validate algorithms that indicate bearing “condition”” See Exhibit 2154, dated August 2, 2011; Slide 3. “Criteria 3 & 4

	Deviation from Car/Fleet Average • These criteria require temperature readings from all bearings on a car (or all bearings in the fleet) for comparison with a single bearings temperature history. • The car/fleet's average temperature and standard deviation are compared to one bearing's average operating temperature to determine the number of standard deviations between the two.” See Exhibit 2151, dated July 19, 2011, at 16.
21. A method for monitoring the operation of a railcar comprising:	
a. collecting data at periodic intervals about one or more operating parameters of said railcar using one or more sensor units provided on 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”

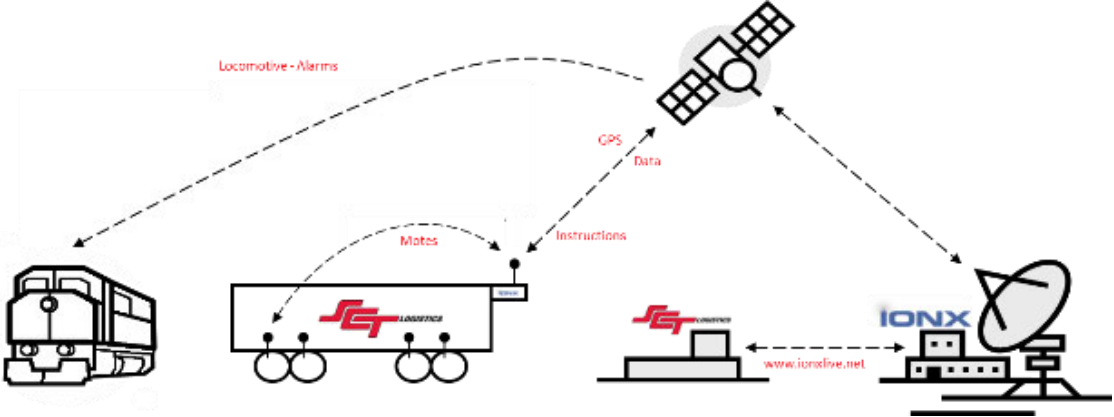


See Exhibit 2154, dated August 2, 2011; Slide 3.

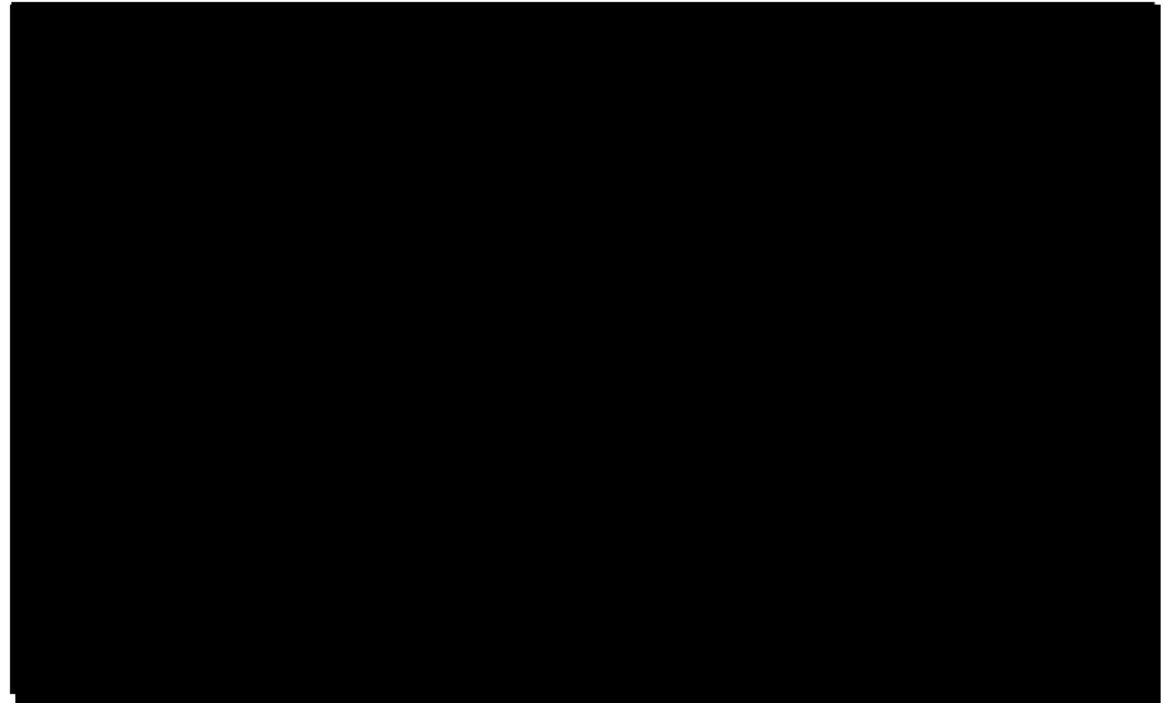
“Progress and Milestones

- 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”

	 See Exhibit 2154, dated August 2, 2011; Slide 4. “Andoni has configured one WSN to report temperature readings every 15 seconds” See Exhibit 2151, dated July 19, 2011, at 19.
b. communicating said collected data to a communication management unit;	“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.
c. analyzing said collected data by applying heuristics thereto to (i) determine if an actual failure exists and (ii) 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.

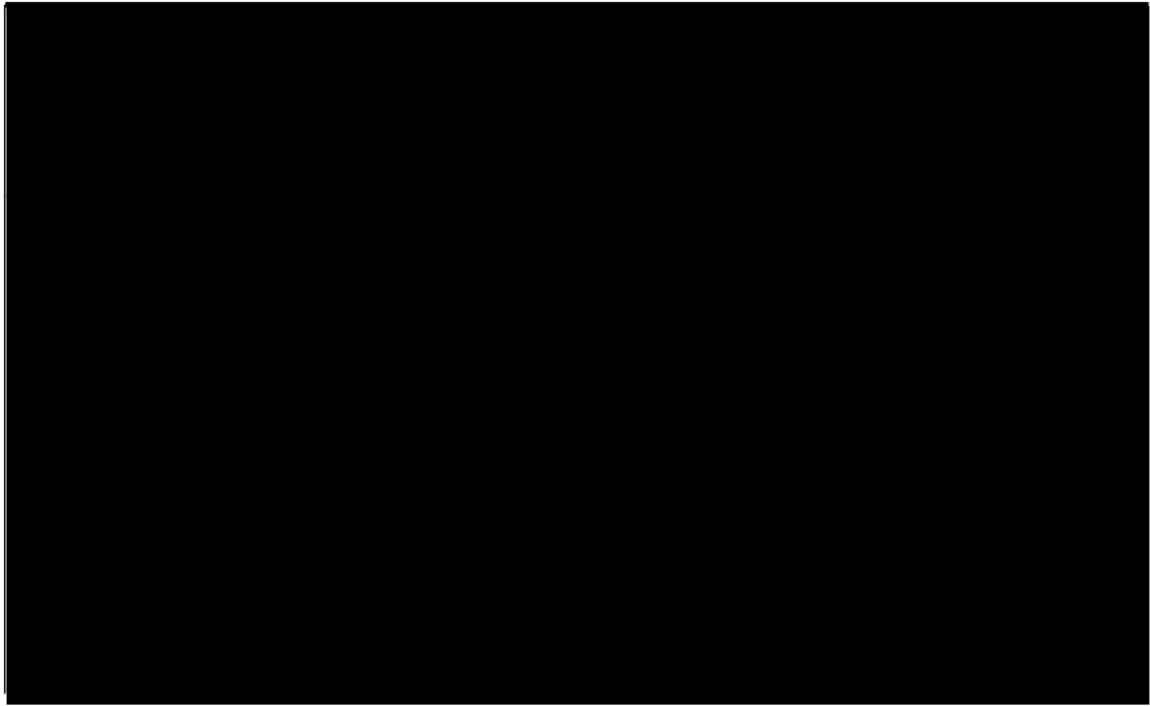
Alert Instructions



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.

22. The method of claim 21 further comprising the steps of:	
assessing the collected data to determine if an alarm condition exists; and wirelessly communicating said alarm condition to an off railcar location.	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. “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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