A method for de-rating propulsion-generating vehicles in a vehicle system includes identifying a feature of interest in a route and identifying one or more propulsion-generating vehicles as de-rating vehicles that are subject to a handling rule associated with the feature of interest. The handling rule dictates that throttle settings be limited to a reduced range when traveling over the feature of interest. The method further includes, when the de-rating vehicles are traveling along the route and outside of the feature of interest, operating the de-rating vehicles using a larger range of throttle settings and, responsive to approaching and/or traveling over the feature of interest, automatically de-rating at least a subset of the propulsion-generating vehicles in the vehicle system by operating the at least a subset of the propulsion-generating vehicles using the smaller range of throttle settings during travel over the feature of interest.
Identify propulsion-generating vehicle(s) in vehicle system having handling rule(s) associated with feature of interest in route

Determine location of consists in vehicle system that include propulsion-generating vehicles

Identify location(s) of feature(s) of interest in route

Monitor location of consists relative to feature(s) of interest during travel along route

Approaching or travelling over feature(s) of interest?

Yes

De-rate propulsion-generating vehicles in all consists

No

Continue to travel along route

Trip completed?

Yes

End trip

No

FIG. 7
Identify propulsion-generating vehicle in vehicle system having handling rule associated with feature of interest in route

Determine location of consists in the vehicle system having any propulsion-generating vehicles

Identify location of feature of interest in route

Monitor locations of consists during travel along route

Is consist approaching or at feature of interest?

De-rate all propulsion-generating vehicles in the consist that is traveling over the feature of interest

Do not de-rate propulsion-generating vehicles in the consist while the non-propulsion-generating vehicles in the vehicle system travel over the feature of interest

Have all consist traveled over the feature of interest?

Terminate de-rating of propulsion generating vehicles in the consist when travel over the feature of interest is complete

Continue to travel along route

FIG. 8
Identify propulsion-generating vehicle in vehicle system having handling rule associated with feature of interest in route

Determine which consist includes the identified propulsion-generating vehicle

Determine location of the consists having the identified propulsion-generating vehicle in the vehicle system

Identify location of feature of interest in route

Monitor location of consist having identified propulsion-generating vehicle during travel along route

Is consist approaching or at feature of interest?

Yes

De-rate all propulsion-generating vehicles in the consist having the identified propulsion-generating vehicle during travel over the feature of interest

No

Do not de-rate propulsion-generating vehicles in the vehicle system during travel on the route

Have all consists traveled over feature of interest?

No

Yes

Terminate de-rating of propulsion-generating vehicles in the consist when travel over the feature of interest is complete

Continue to travel along route

FIG. 9
1. Identify propulsion-generating vehicle in a vehicle system having handling rules associated with a feature of interest in a route.

2. Determine locations of the identified vehicles in the vehicle system.

3. Identify location of the feature of interest in the route.

4. Monitor location of identified vehicles relative to the feature of interest during travel along the route.

5. Is identified vehicle at or approaching the feature of interest?
   - Yes: De-rate the identified vehicle during travel over the feature of interest.
   - No: Do not de-rate propulsion-generating vehicles during travel.

6. Have all propulsion-generating vehicles traveled over the feature of interest?
   - No: Continue to travel along route.
   - Yes: Terminate de-rating of the identified vehicle when travel over the feature of interest is completed.

FIG. 10
FIG. 11

Communication apparatus 1114
Identification apparatus 1118
Control apparatus 1104
Energy management system 1112
Propulsion system 1110
Location determination apparatus 1102
Input device 1106
Output device 1108
SYSTEM AND METHOD FOR CONTROLLING DE-RATING OF PROPULSION-GENERATING VEHICLES IN A VEHICLE SYSTEM

FIELD

[0001] Embodiments of the subject matter described herein relate to controlling motive operations of propulsion-generating vehicles.

BACKGROUND

[0002] A vehicle “consist” is a group of one or more vehicles that are mechanically coupled to travel together along a route. For example, a train may include one or more locomotive consists that act to propel the train along a track. The train may move through and/or across a variety of features in the track, such as crossings, bridges, and the like. Some locomotives may need to travel slower over one or more of these features in order to avoid damaging components of the locomotives.

[0003] For example, locomotives that are powered by direct current supplied from an electrified rail may receive the current via one or more brushes that engage the electrified rail. These brushes may become damaged if the locomotives travel too fast over a crossing between tracks. Other types of locomotives, such as those powered by alternating current supplied by a catenary, may not need to slow down when traveling through such crossings as the locomotives do not include the brushes that may be damaged.

[0004] The operators of some trains may not be fully aware of whether the trains include one or more locomotives that need to travel slower through crossings and/or where such locomotives are located in the trains. As a result, the trains may be operated at slower speeds than is necessary in an abundance of caution to avoid damaging components of the locomotives. For those trains that do include one or more locomotives that require the slower speeds through crossings, the operators may unnecessarily slow movement of all locomotives, including those that do not require the slower travel, through the crossings. Unnecessary slowing of the trains results in reduced throughput of the trains in a network of tracks, trains operating behind schedules, and the like.

BRIEF DESCRIPTION

[0005] In an embodiment, a method (e.g., for controlling de-rating of propulsion-generating vehicles in a vehicle system) includes identifying a feature of interest in a route to be traveled or being traveled by a vehicle system having plural propulsion-generating vehicles and identifying one or more of the propulsion-generating vehicles as de-rating vehicles that are subject to a handling rule associated with the feature of interest. The handling rule dictates that throttle settings of the de-rating vehicles are to be limited to a reduced range of throttle settings when the de-rating vehicles travel over or through the feature of interest in the route. The reduced range of throttle settings is a smaller range of throttle settings that the de-rating vehicles are permitted to use relative to a larger range of throttle settings that the de-rating vehicles are permitted to use when traveling on the route outside of the feature of interest.

[0006] In an embodiment, a system (e.g., a control system) includes an identification apparatus, a location determination apparatus, and a control apparatus. The identification apparatus is configured to determine which propulsion-generating vehicles in a vehicle system having plural interconnected propulsion-generating vehicles are de-rating vehicles that are subject to a handling rule associated with a feature of interest in a route to be traveled or being traveled by the vehicle system. The handling rule dictates that throttle settings of the de-rating vehicles be limited to a reduced range of throttle settings when the de-rating vehicles travel over or through the route of interest in the route. The reduced range of throttle settings is a smaller range of throttle settings that the de-rating vehicles are permitted to use relative to a larger range of throttle settings that the de-rating vehicles are permitted to use when traveling on the route outside of the feature of interest.

[0007] In an embodiment, a method (e.g., for controlling de-rating of a vehicle consist) includes automatically controlling throttle settings of a rail vehicle consist as the rail vehicle consist travels along a track. The rail vehicle consist has a lead vehicle consist and at least one remote vehicle consist that each include one or more propulsion-generating rail vehicles and that are connected with each other by one or more non-propulsion-generating rail vehicles disposed between the lead vehicle consist and the at least one remote vehicle consist. The method also includes de-rating the propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist while the lead vehicle consist and the at least one remote vehicle consist are traveling over a designated track feature. The propulsion-generating rail vehicles are de-rated by limiting the throttle settings of the propulsion-generating rail vehicles to a designated first maximum throttle level that is less than a second maximum throttle level that the propulsion-generating rail vehicles are controlled to when not traveling over the designated track feature.

The method further includes de-rating the propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist while the one or more non-propulsion-generating rail vehicles are traveling over the designated track feature but not de-rating the propulsion-generating vehicles in each of the lead vehicle consist and the at least one remote vehicle consist after a last of the at least one remote vehicle consist, in a direction of travel of the rail vehicle consist, has passed over the designated track feature.
In an embodiment, a method (e.g., for controlling de-rating of a vehicle consist) includes automatically controlling throttle settings of a rail vehicle consist as the rail vehicle consist travels along a track. The rail vehicle consist has a lead vehicle consist and at least one remote vehicle consist that each include one or more propulsion-generating rail vehicles and that are connected with each other by one or more non-propulsion-generating rail vehicles disposed between the lead vehicle consist and the at least one remote vehicle consist. Automatically controlling the throttle settings of the rail vehicle consist comprises automatic operation of the rail vehicle consist in at least one of a first, second, third, or fourth mode of operation.

The first mode of operation involves the propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist being automatically de-rated while the lead vehicle consist and the at least one remote vehicle consist are traveling over a designated track feature. The propulsion-generating rail vehicles are de-rated by limiting the throttle settings of the propulsion-generating rail vehicles to a designated first maximum throttle level that is less than a second maximum throttle level that the propulsion-generating rail vehicles are controlled to when not traveling over the designated track feature. The propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist are automatically de-rated while the one or more non-propulsion-generating rail vehicles are traveling over the designated track feature.

The second mode of operation involves all the propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist being automatically de-rated only while the lead vehicle consist and the at least one remote vehicle consist are traveling over the designated track feature but not while the one or more non-propulsion-generating rail vehicles are traveling over the designated track feature.

The third mode of operation involves, for each of the lead vehicle consist and the at least one remote vehicle consist, all the propulsion-generating rail vehicles in the consist being automatically de-rated but only if at least one of the propulsion-generating rail vehicles in the consist is designated for operation at no more than the designated first maximum throttle level when traveling over the designated track feature.

The fourth mode of operation involves, while the vehicle consist is traveling over the designated track feature, only those propulsion-generating rail vehicles in the consist that are designated for operation at no more than the designated first maximum throttle level when traveling over the designated track feature being automatically de-rated.

FIG. 4 illustrates an example of a feature of interest that may be associated with one or more handling rules; FIG. 5 illustrates an example of a feature of interest that may be associated with one or more handling rules; FIG. 6 illustrates an example of a feature of interest that may be associated with one or more handling rules; FIG. 7 illustrates a flowchart of an embodiment of a method of controlling operations (e.g., de-rating) of a vehicle system; FIG. 8 illustrates a flowchart of an embodiment of a method of controlling operations (e.g., de-rating) of a vehicle system; FIG. 9 illustrates a flowchart of an embodiment of a method of controlling operations (e.g., de-rating) of a vehicle system; FIG. 10 illustrates a flowchart of an embodiment of a method of controlling operations (e.g., de-rating) of a vehicle system; and FIG. 11 is a schematic illustration of an embodiment of a vehicle.

DETAILED DESCRIPTION

Embodiments of the inventive subject matter described herein relate to changing operating limits imposed on propulsion-generating vehicles in a vehicle system as the vehicle system travels over features of interest in a route when the propulsion-generating vehicles having handling rules associated with the features of interest. As one example, some locomotives in a rail vehicle system may be associated with special rules that restrict throttle settings that may be used for those locomotives when the locomotives travel over a crossing in a track, a bridge, or the like. These locomotives may be electrically powered by direct current (DC) using brushes that may be damaged if the locomotives travel over the feature of interest at too great of a speed. Consequently, the handling rules associated with these types of locomotives may restrict the throttle settings that may be used to control the locomotives as the locomotives travel over the features of interest in the route. Optionally, the locomotives may have one or more other restrictions on the locomotives that limit the throttle settings that may be used during travel over the features of interest. While the description focuses on rail vehicles, not all embodiments are limited to rail vehicles. For example, one or more aspects of the inventive subject matter may be used with other off-highway vehicles (e.g., vehicles that are not designed or permitted for travel on public roads), automobiles, marine vessels, and the like.

A technical effect of embodiments described herein includes improved throughput and faster travel of vehicle systems, such as by avoiding slowing trains having one or more locomotives that require slower travel over features of interest in a track (e.g., crossings, bridges, and the like), when these locomotives are not traveling over the features of interest.

FIG. 1 is a schematic diagram of an embodiment of a vehicle system 100. The vehicle system 100 includes several vehicles 102, 104 (e.g., vehicles 102A-F and vehicles 104A-I) that are interconnected with each other by coupling mechanisms 106, such as couplers. The vehicles 102, 104 are connected such that the vehicles 102, 104 travel together along a route 108. Although six vehicles 102 and four vehicles 104 are shown in FIG. 1, the vehicle system 100 may include a different number and/or arrangement of the vehicles 102 and/or the vehicles 104.
The vehicles 102 represent propulsion-generating vehicles that generate propulsive force (e.g., tractive effort) to propel the vehicle system 100 along the route 108. For example, the vehicles 102 may be locomotives or other types of vehicles that perform work to move the vehicle system 100. The vehicles 102 may be grouped into consists 110 (e.g., consists 110A-C) of the vehicle system 100. Each of the consists 110A, 110B, 110C represents two or more propulsion-generating vehicles 102 that are directly coupled with each other. The consists 110C includes a single propulsion-generating vehicle 102. The number and/or arrangement of the vehicles 102 in the consists 110 may be different from what is shown in FIG. 1.

The consist 110A may be referred to as a leading consist because the consist 110A is disposed ahead of the consists 110B, 110C along a direction of travel 112 of the vehicle system 100. The consists 110B, 110C may be referred to as remote or trailing consists because the consists 110B, 110C are disposed behind the consist 110A along the direction of travel 112 of the vehicle system 100. The consist 110B may be referred to as a leading consist with respect to the consist 110C and a trailing consist with respect to the consist 110A.

The vehicles 104 represent non-propulsion-generating vehicles that do not generate tractive effort. For example, one or more of the vehicles 104 may represent a rail car or another type of vehicle that carries cargo and/or passengers while not generating tractive effort. As shown in FIG. 1, the vehicles 104 may interconnect the consists 110 and separate the consists 110 from each other.

One or more of the propulsion-generating vehicles 102 may be subject to special or different handling rules. These rules may be special or different in that the rules may apply to one or more, but not all, of the propulsion-generating vehicles 102 in the vehicle system 100. A rule may restrict the range of available throttle settings that may be used to control the tractive output (e.g., tractive effort, horsepower, power output, or the like) of the propulsion-generating vehicles 102 subject to the rule when the propulsion-generating vehicles 102 travel over a feature of interest in the route 108 that is associated with the rule. For example, with respect to locomotives, a handling rule may restrict the locomotives subject to the rule to operate using throttle settings that are no greater than a throttle setting of four (out of a total of eight throttle settings) when the locomotives travel over a feature of interest associated with the rule. When the locomotives are traveling outside of the feature of interest (e.g., not over or through the feature of interest), these same locomotives may be allowed to operate using a greater range of throttle settings (e.g., all eight throttle settings).

The handling rules may apply to only those propulsion-generating vehicles 102 in the vehicle system 100 that are a designated type or category of propulsion-generating vehicles 102. For example, the propulsion-generating vehicles 102 that are powered by direct current that is supplied through a conductive pathway extending along the route 108 (e.g., a catenary, electrified rail, or the like) may be subject to a handling rule that restricts the speed (and therefore throttle settings) that can be used during travel through a feature of interest to avoid damage to conductive brushes of the vehicles 102 through which the direct current is conducted to the vehicles 102. Other propulsion-generating vehicles 102 in the same vehicle system 100, such as vehicles 102 powered by alternating current, may not be subject to this same rule. For example, these other vehicles 102 may not be required to travel slower or using a smaller range of throttle settings when traveling through the same feature of interest because these vehicles 102 may not include the conductive brushes that the DC-powered vehicles 102 do.

Similar handling rules may be applicable to vehicles 102 based on the type of motors included in the vehicles 102. For example, different types of motors may need to be operated differently (e.g., using different throttle settings) when traveling over different features of interest in the route 108. Similar handling rules may be applicable to vehicles 102 based on the type of couplers 106 connected to the vehicles 102 or based on one or more other features or characteristics of the vehicles 102.

FIG. 2 illustrates a schematic diagram of the vehicle system 100 traveling on the route 108 toward a feature of interest 200. The feature of interest 200 represents a location in or on the route 108 where operations of one or more of the propulsion-generating vehicles 102 are limited according to the handling rule. The feature of interest 200 can represent a variety of components, structures, and the like, of the route 108.

FIGS. 3 through 6 illustrate some examples of features of interest 300, 400, 500 that may be associated with one or more handling rules. The feature of interest 200 shown in FIG. 2 may represent one or more of the features of interest 300, 400, 500.

The feature of interest 300 shown in FIG. 3 represents an intersection between the route 108 and another route 302. The routes 108, 302 may be the same type of route, such as when both routes 108, 302 represent tracks for rail vehicles. The routes 108, 302 are disposed at right angles with respect to each other and may be referred to as an X-crossing. Optionally, the routes 108, 302 may be different routes, such as a track for rail vehicles and a road for automobiles. Such a crossing between different routes may be referred to as a grade crossing or road crossing.

The feature of interest 400 shown in FIG. 4 represents an intersection between the route 108 and another route 402. The feature of interest 400 may be similar to the feature of interest 300 with one difference being that the routes 108, 402 in the feature of interest 400 may intersect at oblique, or non-perpendicular, angles.

The feature of interest 500 shown in FIGS. 5 and 6 represents a moveable bridge, such as a draw bridge. The bridge is shown in FIG. 5 in a lowered position where the vehicle system 100 may travel across. The bridge is shown in FIG. 6 in a raised position where the vehicle system 100 may not travel across.

Operating the vehicle system 100 at too fast of a speed when traveling across one or more of the features of interest 300, 400, 500 can damage one or more of the propulsion-generating vehicles 102. For example, operating at too large of a throttle setting when crossing the features of interest 300, 400, 500 can damage brushes of a propulsion-generating vehicle 102 that conducts electric current to power the vehicle 102. Optionally, one or more other components of the vehicle 102 may be damaged.

In a first mode of operation, when the vehicle system 100 includes one or more propulsion-generating vehicles 102 having a handling rule associated with the feature of interest 200, the vehicle system 100 is automatically controlled such that the propulsion-generating vehicles 102 in the consists 110 are de-rated while the consists 110 are traveling over a
designated feature of interest 200 in the route 108. The consists 110 may be de-rated by limiting operation of these propulsion-generating vehicles 102 to a designated first maximum throttle level that is less than a second maximum throttle level that the propulsion-generating vehicles 102 are controlled to when the consists 110 are not traveling over the feature of interest 200. The vehicle system 100 may be controlled in this manner such that the propulsion-generating vehicles 102 are de-rated for a time period that includes when the non-propulsion-generating vehicles 104 disposed between the consists 110 are traveling over the feature of interest 200. For example, all of the propulsion-generating vehicles 102 in all of the consists 110 de-rated for the entire time that the propulsion-generating vehicles 102 and the intervening non-propulsion-generating vehicles 104-A-C are moving over the feature of interest 200. The intervening vehicles 104 between the consists 110-A and 110-B include the vehicles 104-A and 104-B and the intervening vehicles 104 between the consists 110-B and 110-C include the vehicle 104-C. Once the last consist 110-C completes travel over the feature of interest 200, the de-rating of the propulsion-generating vehicles 102 may terminate such that the propulsion-generating vehicles 102 may be throttled back up. For example, greater throttle settings may be used then in otherwise allowed during travel over the feature of interest 200.

The de-rating of the propulsion-generating vehicles 102 may begin when the first consist 110-A reaches the feature of interest 200 or is within a designated, non-zero distance from the feature of interest 200 and continue until when the last consist 110-C completes travel over the feature of interest 200.

[0041] In a second mode of operation, when the vehicle system 100 includes one or more propulsion-generating vehicles 102 having a handling rule associated with the feature of interest 200, the vehicle system 100 is automatically controlled such that all of the propulsion-generating vehicles 102 in the consists 110 are de-rated only when the consists 110 are actually traveling over the feature of interest 200. For example, all of the propulsion-generating vehicles 102-A-F may be de-rated during the entire time period that the consist 110-A is traveling over the feature of interest 200, during the entire time period that the consist 110-B is traveling over the feature of interest 200, and during the entire time period that the consist 110-C is traveling over the feature of interest 200, but not during the time periods when the non-propulsion-generating vehicles 104 are traveling over the feature of interest 200. All propulsion-generating vehicles 102 in a consist 110 may be de-rated during travel of that consist 110 over the feature of interest 200, even if one or more of the consists 110 do not include any vehicles 102 that are subject to any handling rule associated with the feature of interest 200.

[0042] In a third mode of operation, when the vehicle system 100 includes one or more propulsion-generating vehicles 102 having a handling rule associated with the feature of interest 200, the vehicle system 100 is automatically controlled such that all of the propulsion-generating vehicles 102 in the consists 110 having at least one of the propulsion-generating vehicles 102 having a handling rule are de-rated when those consists 110 are traveling over the feature of interest 200. The propulsion-generating vehicles 102 in the consists 110 that do not include a propulsion-generating vehicle 102 having a handling rule are not de-rated when those consists 110 travel over the feature of interest 200. For example, if the propulsion-generating vehicle 102-F has a handling rule associated with the feature of interest 200 but the remaining propulsion-generating vehicles 102-A-D, 102-F do not, then the vehicle system 100 may be automatically controlled to de-rate all of the propulsion-generating vehicles 102-A-E in the consist 110-B when the consist 110-B is traveling over the feature of interest 200. The remaining propulsion-generating vehicles 102-A, 102-B, 102-F are not de-rated when the consists 110-A-C are traveling over the feature of interest 200.

[0043] In a fourth mode of operation, the de-rating of the propulsion-generating vehicles 102 in the vehicle system 100 is automatically controlled on a vehicle-by-vehicle basis. For example, instead of de-rating all of the vehicles 102 or all of the vehicles 102 in one or more consists 110 when the consists 110 travel over the feature of interest 200, only those vehicles 102 having a handling rule associated with the feature of interest 200 are de-rated when those vehicles 102 travel over the feature of interest 200.

[0044] The vehicle system 100 may switch between two or more of the previously described modes of operation during a single trip between a starting location and a destination location depending on the type of feature of interest 200. For example, the vehicle system 100 may operate according to the first mode of operation when traveling over the feature of interest 300, according to the second mode of operation when traveling over the feature of interest 400, according to the third mode of operation when traveling over the feature of interest 500, and/or according to the fourth mode of operation when traveling over another feature of interest.

[0045] FIG. 7 illustrates a flowchart of an embodiment of a method 700 of controlling operations of a vehicle system. The method 700 may be used to control operations of the vehicle system 100 shown in FIG. 1. The method 700 may represent one aspect of the first mode of operation described above.

[0046] At 702, one or more propulsion-generating vehicles 102 (shown in FIG. 1) in the vehicle system 100 that have handling rules associated with a feature of interest 200 (shown in FIG. 2) in the route 108 (shown in FIG. 1) are identified. For example, a determination may be made as to which of the vehicles 102 are subject to a handling rule that reduces the range of throttle settings that may be used for the vehicles 102 during travel over the feature of interest 200. The vehicles 102 that are identified as being subject to the handling rule associated with an upcoming feature of interest 200 may be referred to as ‘de-rating vehicles’.

[0047] At 704, the locations of two or more of the consists 110 (shown in FIG. 1) in the vehicle system 100 are determined. For example, the location of the leading consist 110-A (e.g., the first consist 110 along the direction of travel 112 of the vehicle system 100) and the location of the last trailing consist 110-C (e.g., the last consist 110 along the direction of travel 112) may be identified. The locations of these consists 110 may be used to determine when to implement the handling rule and de-rate the vehicles 102.

[0048] At 706, the location of one or more features of interest 200 associated with the handling rule imposed on the vehicle system 100 is determined. For example, the geographic locations of one or more features of interest 200 associated with the handling rule may be identified.

[0049] At 708, locations of the consists 110 along the route 108 are monitored as the vehicle system 100 travels along the route 108. These locations may be monitored to determine when the leading consist 110 (e.g., the first consist 110-A) is at or within a designated distance from the feature of interest 200 along the route 108.
[0050] At 710, a determination is made as to whether the first consist 110A in the vehicle system 100 is at or within the designated distance from the feature of interest 200. If the first consist 110A is at or close to the feature of interest 200, then operations of the propulsion-generating vehicles 102 may need to be automatically de-rated in order to ensure that the vehicles 102 subject to the handling rule are not operated at too great of throttle settings during travel over the feature of interest 200. As a result, flow of the method 700 may proceed to 712. Otherwise, flow of the method 700 may proceed to 714.

[0051] At 712, operations of all the propulsion-generating vehicles 102 in all of the consists 110 of the vehicle system 100 are de-rated. For example, the available range of throttle settings that may be used to control the vehicles 102 in all of the consists 110 may be reduced once the first consist 110A is at or is close to the feature of interest 200. The method 700 may return to 708 where the location of the last consist 110C in the vehicle system 100 is monitored. The method 700 may monitor the location of this consist 110C to determine when all of the consists 110 in the vehicle system 100 have completed travel over the feature of interest 200. Once this last consist 110C has completed travel over the feature of interest 200 (e.g., determined at 710), then flow of the method 700 may proceed to 714.

[0052] At 714, the vehicle system 100 continues to travel along the route 108. At 716, if the trip of the vehicle system 100 along the route 108 has not been completed, the method 700 may return to 708 to continue monitoring the location of the consists 110 relative to any upcoming features of interest 200. If the trip has been completed, then the trip may terminate at 718.

[0053] FIG. 8 illustrates a flowchart of an embodiment of a method 800 of controlling operations of a vehicle system. The method 800 may be used to control operations of the vehicle system 100 shown in FIG. 1. The method 800 may represent one aspect of the second mode of operation of the vehicle system 100 described above.

[0054] At 802, one or more propulsion-generating vehicles 102 (shown in FIG. 1) in the vehicle system 100 that have handling rules associated with a feature of interest 200 (shown in FIG. 2) in the route 108 (shown in FIG. 1) are identified. For example, a determination may be made as to which of the vehicles 102 are subject to a handling rule that reduces the range of throttle settings that may be used for the vehicles 102 during travel over the feature of interest 200.

[0055] At 804, the locations of the consists 110 (shown in FIG. 1) in the vehicle system 100 that include any of the propulsion-generating vehicles 102 are determined. For example, the positions of the consists 110 in the vehicle system 100 are determined, regardless of whether one or more of the consists 110 do not include any vehicles 102 that are subject to a handling rule associated with the feature of interest 200.

[0056] At 806, the location of one or more features of interest 200 associated with the handling rule imposed on the vehicle system 100 is determined. For example, the geographic locations of one or more features of interest 200 associated with the handling rule may be identified.

[0057] At 808, locations of the consists 110 along the route 108 are monitored as the vehicle system 100 travels along the route 108. These locations may be monitored to determine when each of the consists 110 is at or within a designated distance from the feature of interest 200 along the route 108.

[0058] At 810, a determination is made as to whether any of the consists 110 in the vehicle system 100 are at or within a designated distance from the feature of interest 200. For example, if the vehicle system 100 is first approaching the feature of interest 200, the determination is made as to whether the first consist 110A is approaching or is at the feature of interest 200. If the first consist 110A already has passed over the feature of interest 200, then the determination may be made as to whether the second consist 110B is at or approaching the feature of interest 200, and so on.

[0059] If a consist 110 is approaching or at the feature of interest 200, then the propulsion-generating vehicles 102 in that consist 110 may need to be de-rated to ensure compliance with the handling rule, even if that consist 110 does not include any propulsion-generating vehicles 102 that are subject to a handling rule associated with the feature of interest 200. In some circumstances, the exact location of the vehicle 102 having the handling rule associated with the feature of interest 200 may not be known. Therefore, all propulsion-generating vehicles 102 in a consist 110 may be de-rated when that consist 110 travels over the feature of interest 200 in an abundance of caution to prevent violating the feature of interest 200.

[0060] If a consist 110 is approaching or at the feature of interest 200, flow of the method 800 proceeds to 812. Otherwise, if no consist 110 is at or approaching the feature of interest 200, then flow of the method 800 proceeds to 816. For example, the vehicle system 100 may still be relatively far from the feature of interest 200 or one or more of the intervening non-propulsion-generating vehicles 104 between the consists 110 may currently be traveling over the feature of interest 200.

[0061] At 812, all of the propulsion-generating vehicles 102 in the consist 110 that is at or is traveling over the feature of interest 200 in the route 108 are de-rated. For example, the throttle settings that may be used to control these vehicles 102 may be reduced to a smaller range than would otherwise be used by the vehicles 102 when the vehicles 102 are de-rated. The propulsion-generating vehicles 102 in the other consists 110 of the vehicle system 100 that are not at or traveling over the feature of interest 200 may not be de-rated. These vehicles 102 may continue to operate using a larger range of throttle settings than the vehicles 102 would be able to use when these vehicles 102 are de-rated.

[0062] At 814, the de-rating of the propulsion-generating vehicles 102 in the consist 110 that traveled over the feature of interest 200 is terminated once that consist 110 completes travel over the feature of interest 200. For example, when the last vehicle 102 in the consist 110 that was traveling over the feature of interest 200 travels over and past the feature of interest 200, all of the vehicles 102 in that consist 110 may return to operating using a larger range of throttle settings relative to when those vehicles 102 were de-rated.

[0063] At 816, the propulsion-generating vehicles 102 in the consists 110 of the vehicle system 100 are not de-rated during travel of the non-propulsion-generating vehicles 104 over the feature of interest 200. For example, during the time period when intervening vehicles 104 disposed between the consists 110 travel over the feature of interest 200, the propulsion-generating vehicles 102 may operate using the larger range of throttle settings (relative to the allowable range of throttle settings that are used when these vehicles 102 are de-rated).
At 818, a determination is made as to whether all of the consists 110 in the vehicle system 100 have completed travel over the feature of interest 200. For example, if the last consist 110C along the direction of travel 112 of the vehicle system 100 has traveled over and past the feature of interest 200, then there are no more consists 110 in the vehicle system 100 to travel over the feature of interest 200. Accordingly, the propulsion-generating vehicles 102 do not need to be de-rated for the feature of interest 200 that was just traveled over as all of these vehicles 102 already have traveled over the feature of interest 200. As a result, flow of the method 800 may continue to 820.

On the other hand, if one or more additional consists 110 in the vehicle system 100 have yet to travel over the feature of interest 200, then the propulsion-generating vehicles 102 in those additional consists 110 may need to be de-rated during travel over the feature of interest 200 to ensure compliance with the handling rules that may apply to one or more of these vehicles 102. As a result, flow of the method 800 returns to 808.

At 820, travel of the vehicle system 100 continues along the route 108 until the trip of the vehicle system 100 is completed. Optionally, if one or more additional features of interest 200 are encountered, then the method 800 may be repeated.

FIG. 9 illustrates a flowchart of an embodiment of a method 900 of controlling operations of a vehicle system. The method 900 may be used to control operations of the vehicle system 100 shown in FIG. 1. The method 900 may represent one aspect of the third mode of operation of the vehicle system 100 described above.

At 902, one or more propulsion-generating vehicles 102 (shown in FIG. 1) in the vehicle system 100 that have handling rules associated with a feature of interest 200 (shown in FIG. 2) in the route 108 (shown in FIG. 1) are identified. For example, a determination may be made as to which of the vehicles 102 are subject to a handling rule that reduces the range of throttle settings that may be used for the vehicles 102 during travel over the feature of interest 200.

At 904, a determination is made as to which consists 110 (shown in FIG. 1) of the vehicle system 100 include the identified propulsion-generating vehicles 102. For example, the consists 110 that include one or more propulsion-generating vehicles 102 having a handling rule associated with the feature of interest 200 may be identified.

At 906, the location of the consist(s) 110 in the vehicle system 100 that includes the propulsion-generating vehicle 102 having the handling rule associated with the feature of interest 200 is determined. For example, the positions in the vehicle system 100 of the consists 110 having one or more of the vehicles 102 that are subject to the handling rule are determined.

At 908, the location of one or more features of interest 200 associated with the handling rule imposed on the vehicle system 100 is determined. For example, the geographic locations of one or more features of interest 200 associated with the handling rule may be identified.

At 910, locations of the consists 110 having the identified propulsion-generating vehicle(s) 102 are monitored as the vehicle system 100 travels along the route 108. For example, for those consists 110 that include one or more vehicles 102 subject to the handling rule, the locations of those consists 110 along the route 108 are tracked. The locations of these consists 110 may be monitored to determine when these consists 110 are at or within a designated distance from the feature of interest 200 along the route 108.

At 912, a determination is made as to whether a consist 110 having an identified propulsion-generating vehicle 102 is at or within a designated distance from the feature of interest 200. For example, if the consist 110 includes a vehicle 102 that is subject to a handling rule associated with the feature of interest 200, then a determination may be made as to whether the consist 110 is at or approaching the feature of interest 200. In one aspect, this determination may not be performed for consists 110 that do not include any propulsion-generating vehicle 102 that is subject to a handling rule associated with the feature of interest 200.

If the consist 110 having the identified propulsion-generating vehicle 102 is at or approaching the feature of interest 200, then the propulsion-generating vehicles 102 in that consist 110 may need to be de-rated to ensure compliance with the handling rule, even if not all of the propulsion-generating vehicles 102 in that consist 110 are subject to a handling rule associated with the feature of interest 200. In some circumstances, the exact location of the vehicle 102 having the handling rule in the consist 110 may not be known. Therefore, all propulsion-generating vehicles 102 in the consist 110 having at least one vehicle 102 that is subject to the handling rule may be de-rated when that consist 110 travels over the feature of interest 200. As shown in FIG. 9, if the consist 110 having the identified vehicle 102 is approaching the feature of interest 200, flow of the method 900 proceeds to 914.

On the other hand, if the consist 110 that is approaching the feature of interest 200 does not include a propulsion-generating vehicle 102 that is subject to the handling rule, then the vehicles 102 in that consist 110 may not need to be de-rated during travel over the feature of interest 200. Accordingly, flow of the method 900 proceeds to 918.

At 914, the propulsion-generating vehicles 102 in the consist 110 that is at or is traveling over the feature of interest 200 in the route 108 are de-rated. For example, for a consist 110 having at least one propulsion-generating vehicle 102 having a handling rule associated with the feature of interest 200, all of the vehicles 102 in that consist 110 may be de-rated during travel of the consist 110 over the feature of interest 200.

At 916, the de-rating of the propulsion-generating vehicles 102 in the consist 110 that includes at least one vehicle 102 subject to the handling rule is terminated once that consist 110 completes travel over the feature of interest 200. For example, when the last vehicle 102 in the consist 110 that was traveling over the feature of interest 200 travels over and past the feature of interest 200, all of the vehicles 102 in that consist 110 may return to operating using a larger range of throttle settings relative to when those vehicles 102 were de-rated.

At 918, the propulsion-generating vehicles 102 in the consists 110 that do not include one or more vehicles 102 subject to the handling rule associated with the feature of interest 200 travel over the feature of interest 200 without being de-rated. For example, during the time period when those other consists 110 travel over the feature of interest 200, the propulsion-generating vehicles 102 in those other consists 110 may operate using the larger range of throttle settings (relative to the allowable range of throttle settings for a de-rated vehicle 102).
At 920, a determination is made as to whether all of the consists 110 in the vehicle system 100 have completed travel over the feature of interest 200. For example, if the last consist 110C along the direction of travel 112 of the vehicle system 100 has traveled over and past the feature of interest 200, then there are no more consists 110 in the vehicle system 100 to travel over the feature of interest 200. As a result, flow of the method 900 may continue to 922. On the other hand, if one or more additional consists 110 in the vehicle system 100 have yet to travel over the feature of interest 200, then flow of the method 900 may return to 910.

At 922, travel of the vehicle system 100 continues along the route 108 until the trip of the vehicle system 100 is completed. Optionally, if one or more additional features of interest 200 are encountered, then the method 900 may be repeated.

FIG. 10 illustrates a flowchart of an embodiment of a method 1000 of controlling operations of a vehicle system. The method 1000 may be used to control operations of the vehicle system 100 shown in FIG. 1. The method 1000 may represent one aspect of the fourth mode of operation of the vehicle system 100 described above.

At 1002, one or more propulsion-generating vehicles 102 (shown in FIG. 1) in the vehicle system 100 that have handling rules associated with a feature of interest 200 (shown in FIG. 2) in the route 108 (shown in FIG. 1) are identified. For example, a determination may be made as to which of the vehicles 102 are subject to a handling rule that reduces the range of throttle settings that may be used for the vehicles 102 during travel over the feature of interest 200.

At 1004, the locations of the identified propulsion-generating vehicles 102 in the vehicle system 100 are determined. For example, the positions (within the vehicle system 100) of the vehicles 102 that are subject to the handling rule are determined.

At 1006, the location of one or more features of interest 200 associated with the handling rule imposed on the vehicle system 100 is determined. For example, the geographic locations of one or more features of interest 200 associated with the handling rule may be identified.

At 1008, locations of the identified propulsion-generating vehicles 102 are monitored as the vehicle system 100 travels along the route 108. For example, the locations of the vehicles 102 subject to the handling rule are tracked. The locations of these identified vehicles 102 may be monitored to determine when the identified vehicles 102 are at or within a designated distance from the feature of interest 200 along the route 108.

At 1010, a determination is made as to whether an identified vehicle 102 is at or within a designated distance from the feature of interest 200. For example, if the vehicle 102C is subject to a handling rule associated with the feature of interest 200, then a determination may be made as to whether the vehicle 102C is at or approaching the feature of interest 200. In one aspect, this determination may not be performed for the vehicles 102 that are not subject to the handling rule associated with the feature of interest 200.

If the identified vehicle 102 is at or approaching the feature of interest 200, then the identified vehicle 102 may need to be de-rated to ensure compliance with the handling rule. As a result, flow of the method 1000 can proceed to 1012.

On the other hand, if the vehicle 102 that is approaching the feature of interest 200 is not subject to the handling rule, then that vehicle 102 may not need to be de-rated during travel over the feature of interest 200. Accordingly, flow of the method 1000 can proceed to 1016.

At 1012, the identified vehicle 102 that is at or is traveling over the feature of interest 200 in the route 108 is de-rated during the time period that the identified vehicle 102 is traveling over the feature of interest 200. The other propulsion-generating vehicles 102 in the vehicle system 100 may not be de-rated during this same time period.

At 1014, the de-rating of the identified vehicle 102 is terminated once that identified vehicle 102 completes travel over the feature of interest 200. For example, when the identified vehicle 102 travels over and past the feature of interest 200, the identified vehicle may return to operating using a larger range of throttle settings relative to when the identified vehicle 102 was de-rated.

At 1016, the other propulsion-generating vehicles 102 in the vehicle system 100 that are not subject to the handling rule travel over the feature of interest 200 without being de-rated. For example, the method 1000 may de-rate individual ones of the vehicles 102 that are subject to the handling rule during the time period when those vehicles 102 are traveling over the feature of interest 200 without de-rating other vehicles 102 during this same time period.

At 1018, a determination is made as to whether all of the propulsion-generating vehicles 102 in the vehicle system 100 that are subject to the handling rule of the feature of interest 200 have completed travel over the feature of interest 200. For example, if the last vehicle 102 along the direction of travel 112 of the vehicle system 100 that is subject to the handling rule has traveled over and past the feature of interest 200, then there are no more vehicles 102 in the vehicle system 100 to de-rate according to the handling rule during the time over the feature of interest 200. As a result, flow of the method 1000 may continue to 1020. On the other hand, if one or more additional vehicles 102 that are subject to the handling rule have yet to travel over the feature of interest 200, then flow of the method 1000 may return to 1008.

At 1020, travel of the vehicle system 100 continues along the route 108 until the trip of the vehicle system 100 is completed. Optionally, if one or more additional features of interest 200 are encountered, then the method 1000 may be repeated.

FIG. 11 is a schematic illustration of an embodiment of a vehicle 1100. The vehicle 1100 may represent one or more of the propulsion-generating vehicles 102 shown in FIG. 1. The vehicle 600 includes several components described below that may be coupled with each other by one or more wired and/or wireless connections (not shown), such as wireless networks, conductive paths, and the like. The components may include or represent one or more processors, controllers, or other logic based devices (and/or associated hardware, circuitry, and/or software stored on a tangible and non-transitory computer readable medium or memory). The components shown in FIG. 11 may represent the hardware that operates based on software or hardwired instructions, the software that directs hardware to perform the operations, or a combination thereof. One or more of the components shown in FIG. 11 may be disposed off-board of the vehicle 1100. One or more of the components shown in FIG. 11 may be used to perform the operations described in connection with the methods described above.

The vehicle 1100 includes a location determining apparatus 1102 that determines locations of the vehicle 1100 as the vehicle 1100 travels along the route 108 (shown in FIG.
1). The location determining apparatus 1102 may include or represent a global positioning system (GPS) receiver (and associated hardware and/or circuitry), a wireless cellular antenna (and associated hardware and/or circuitry), or another wireless device that determines the locations of the vehicle 1100 based on received wireless signals, such as from GPS satellites, cellular phone towers, or the like. Optionally, the location determining apparatus 1102 may interrogate or be interrogated by a roadside device disposed alongside the route 108 (e.g., using RFID tags). The apparatus 1102 may determine the location from information obtained during this interrogation. As another example, the apparatus 1102 may determine the location of the vehicle 1100 based on the speed of the vehicle 1100 (which may be monitored by one or more speed sensors, such as tachometers) and a time elapsed since the vehicle 1100 was at a known location along the route 108.

[0096] A control apparatus 1104 controls operations of the vehicle 1100. The control apparatus 1104 may communicate with one or more input devices 1106 and/or output devices 1108 in order to communicate with an operator of the vehicle 1100. The control apparatus 1104 may receive manually input commands to control the active efforts and/or braking efforts generated by a propulsion system 1110 of the vehicle 1100. The propulsion system 1110 represents one or more engines, motors, alternators, generators, batteries, brakes, and the like, that generate the active efforts and/or braking efforts of the vehicle 1100 as commanded and controlled by the control apparatus 1104. The input device 1106 can include a throttle that is manually manipulated by the operator to change between different throttle settings to vary the amount of active effort, power output, or the like, generated by the propulsion system 1110.

[0097] Optionally, the control apparatus 1104 may automatically control the active efforts (e.g., throttle settings) and/or brake settings of the propulsion system 1110. For example, the control apparatus 1104 may control the throttle and/or brake settings of the vehicle 1100 according to designated operational settings of a trip plan for the vehicle system 100. The trip plan may be generated and/or modified by an off-board source (e.g., a dispatch center that communicates the trip plan to the vehicle 1100) or by an onboard energy management system 1112. Optionally, the energy management system 1112 may be located off-board of the vehicle 1100. The energy management system 1112 may include or represent one or more processors, controllers, or other logic-based devices (and/or associated hardware, circuitry, and/or software stored in a tangible and non-transitory computer-readable medium or memory) that create and/or modify trip plans for the vehicle system 100 that includes the vehicle 1100. The trip plan may be based on a variety of relevant information, such as the size (e.g., length and/or weight) of the vehicle system 100, the distribution of size (e.g., the distribution of weight) throughout the vehicle system 100, the contents of the vehicle system 100 (e.g., the number, type, capabilities, locations, and the like, of the propulsion-generating vehicles in the vehicle system 100), the terrain (e.g., grades, curves, locations of tunnels, locations of slow orders, speed limits, and the like) over which the vehicle system 100 is to travel for the trip, the schedule by which the vehicle system 100 is to travel according to for the trip, weather conditions, types of fuel being used, emissions restrictions on travel of the vehicle system 100, and/or other factors.

[0098] The trip plan created and/or modified by the energy management system 1112 designates operational settings of the vehicle system 100 for a trip. These operational settings may be designated as a function of time and/or distance along the route 108 for the trip to one or more locations (e.g., one or more intermediate or final locations). By way of example only, the operational settings that may be designated include, but are not limited to, speeds, accelerations, power outputs, throttle settings, brake settings, applications of full lubricants, forces exerted on coupling mechanisms 106 (shown in FIG. 1), or the like. An example trip plan may designate throttle settings, speeds, power outputs, brake settings, or the like, to reduce at least one of fuel consumed and/or emissions generated by the vehicle system 100 relative to the vehicle system 100 being operated according to another trip plan or in another manner. The control apparatus 1104 may automatically control throttle and/or brake settings of the vehicle system 100 in an attempt to match the actual operations (e.g., speed, power output, and the like) with the designated operational settings of the trip plan.

[0099] Optionally, the energy management system 1112 and/or the control apparatus 1104 may instruct the operator how to manually control operations of the vehicle 1100 and/or vehicle system 100 according to the trip plan. For example, the energy management system 1112 and/or control apparatus 1104 may visually, audibly, and/or tactically present instructions to an operator on how to control the vehicle 1100 and/or vehicle system 100 according to the trip plan via the one or more output devices 1108 (e.g., display screens; touch-screens; speakers; tactically actuated levers, buttons, switches, and the like).

[0100] A communication apparatus 1114 of the vehicle 1100 communicates with other vehicles in the vehicle system 100 and/or other remote locations that are off-board the vehicle system 100. The communication apparatus 1114 may include or represent an antenna (along with associated transceiver hardware circuitry and/or software applications) for wirelessly communicating with other vehicles and/or remote locations. The communication apparatus 1114 may receive information representative of the locations of the features of interest 200 (shown in FIG. 2) along the route 108, the identification of handling rules applicable to the vehicle 1100 and/or one or more other vehicles in the vehicle system 100, the reduced range of throttle settings that may be used when the handling rules are applicable to de-rate one or more propulsion-generating vehicles in the vehicle system 100, identification of which handling rules apply to which propulsion-generating vehicles in the vehicle system 100, and the like.

[0101] Optionally, the communication apparatus 1114 is communicatively coupled with one or more other vehicles in the same vehicle system by one or more wired connections 1116. For example, the communication apparatus 1114 may be coupled with a similar or identical communication apparatus disposed onboard another propulsion-generating vehicle in the same consist 110 as the vehicle 1100 by a wired connection. The wired connection may include a multiple unit (MU) cable, a trainline, an electrically controlled pneumatic (ECP) brake line, and the like. The communication apparatuses 1114 disposed onboard the different propulsion-generating vehicles 1100 may communicate network data, such as data that is communicated in data packets. The communication apparatuses 1114 may communicate using high bandwidth or high speed network data, such as by communicating data packets at speeds of at least 256 Kbit/second, at
least 500 Kbit/second, at least 1,000 Kbit/second, and the like. Alternatively, the communication apparatuses 1114 may communicate using different speeds.

[0102] In one aspect, the communication apparatus 1114 communicates with other vehicles to control the automatic de-rating and/or automatic cessation of de-rating using one or more of the communication technologies described in U.S. application Ser. No. 12/683,874, filed 7 Jan. 2010, and titled “System And Method For Communicating Data In Locomotive Consist Or Other Vehicle Consist” (referred to herein as the “874 application”), the entire disclosure of which is incorporated by reference. For example, control instructions that direct one or more of the vehicles 1100 to automatically de-rate or cease de-rating may be communicated between communication apparatuses 1114 on different vehicles 1100 as network data (e.g., data communicated in packet form) and/or high bandwidth network data over the MU cable bus, as described in the ‘874 application. Optionally, these types of control instructions may be communicated between the vehicles 1100 as distributed power (DP) control instructions when the vehicles 1100 are operating in a DP operating mode (e.g., where the operations of the vehicles 1100 are coordinated with each other to produce a total tractive effort, speed, braking effort, or the like, of the vehicle system that includes the vehicles 1100).

[0103] The communication apparatuses 1114 disposed onboard different propulsion-generating vehicles 1100 in the same consist 110 of the vehicle system 100 may communicate with each other to coordinate when the various vehicles 1100 are de-rated during travel over or through the feature of interest 200. For example, in an embodiment where the propulsion-generating vehicles 102 are de-rated on a vehicle-by-vehicle basis (e.g., as described above in connection with the method 1000), the propulsion-generating vehicles 102 in the same consist 110 may communicate with each other using the communication apparatuses 1114 to control if and when one or more of the propulsion-generating vehicles 102 are de-rated during travel over the feature of interest 200.

[0104] An identification apparatus 1118 determines locations of features of interest 200 in the route 108 and/or whether the vehicle 1100 is subject to or more handling rules associated with features of interest 200 along the route 108 to be traveled by the vehicle 1100 during an upcoming trip. Optionally, the identification apparatus 1118 determines whether one or more additional propulsion-generating vehicles in the same vehicle system 100 as the vehicle 1100 are subject to the handling rules. The identification apparatus 1118 may include, represent, and/or have access to a memory (e.g., a tangible and non-transitory computer readable memory, such as a computer hard drive, EEPROM, ROM, RAM, or the like), that has a table, list, database, or other memory structure that identifies various handling rules, the features of interest 200 with which the handling rules are associated, and/or the propulsion-generating vehicles that are subject to the handling rules. In one aspect, the identification apparatus 1118 determines which features of interest 200 are in the route 108 being traveled or to be traveled by the vehicle system 100 during a trip from information stored in the memory and/or from information communicated to the identification apparatus 1118 from a source that is off-board the vehicle 1100. Using this information, the identification apparatus 1118 can identify which propulsion-generating vehicles are subject to one or more handling rules during the current or upcoming trip of the vehicle system 100, and/or how those handling rules restrict the operations (e.g., throttle settings) of the propulsion-generating vehicles when traveling over or through the features of interest 200.

[0105] In order to de-rate the propulsion-generating vehicles that are subject to the handling rules (as described above), the control apparatus 1104 may prevent an operator from increasing the throttle settings of the de-rated propulsion-generating vehicles above a designated throttle setting or outside of a reduced range of throttle settings associated with the handling rule. For example, if an operator attempts to increase the throttle setting of a de-rated propulsion-generating vehicle outside of the reduced range of de-rated throttle settings, the control apparatus 1104 may either prevent the increase in the throttle setting or only allow the throttle setting to increase within the reduced range of throttle settings associated with the handling rule. As another example, if the control apparatus 1104 is automatically controlling a de-rated propulsion-generating vehicle, the control apparatus 1104 may prevent the throttle settings of the de-rated vehicle from increasing outside of the reduced range of throttle settings designated by the handling rule. In one aspect, the control apparatus 1104 may prevent the designated operational settings of a trip plan from being implemented when the designated operational settings would cause the throttle settings of a de-rated propulsion-generating vehicle from exceeding the reduced range of throttle settings associated with a handling rule. Additionally or alternatively, the energy management system 1112 may create the trip plan so that the designated operational settings of the trip plan do not cause or direct a de-rated propulsion-generating vehicle from operating at a throttle setting that exceeds the reduced range of throttle settings associated with a handling rule.

[0106] In an embodiment, a method (e.g., for controlling de-rating of propulsion-generating vehicles in a vehicle system) includes identifying a feature of interest in a route to be traveled or being traveled by a vehicle system having plural propulsion-generating vehicles and identifying one or more of the propulsion-generating vehicles as de-rating vehicles that are subject to a handling rule associated with the feature of interest. The handling rule dictates that throttle settings of the de-rating vehicles are to be limited to a reduced range of throttle settings when the de-rating vehicles travel over or through the feature of interest in the route. The reduced range of throttle settings is a smaller range of throttle settings that the de-rating vehicles are permitted to use relative to a larger range of throttle settings that the de-rating vehicles are permitted to use when traveling on the route outside of the feature of interest. The method also includes, operating the de-rating vehicles using the larger range of throttle settings when the de-rating vehicles are traveling along the route and outside of the feature of interest and, responsive to at least one of the propulsion-generating vehicles in the vehicle system at least one of approaching or traveling over the feature of interest, automatically de-rating at least a subset of the propulsion-generating vehicles in the vehicle system by operating the at least a subset of the propulsion-generating vehicles using the smaller range of throttle settings during travel over the feature of interest.

[0107] In an aspect, automatically de-rating the at least a subset of the propulsion-generating vehicles terminates upon completion of travel over the feature of interest in the route.

[0108] In an aspect, the feature of interest includes at least one of a crossing between the route and at least an additional route or a bridge along the route.
In an aspect, the propulsion-generating vehicles are arranged in two or more consists in the vehicle system, and the consists each includes at least one of the propulsion-generating vehicles. The consists are separated from each other by one or more non-propulsion-generating vehicles in the vehicle system.

In an aspect, automatically de-rating the at least a subset of the propulsion-generating vehicles in the vehicle system includes operating all of the propulsion-generating vehicles in the vehicle system using the smaller range of throttle settings during an entire time period that begins with a first consist along a direction of travel of the vehicle system reaching the feature of interest and that ends with a last consist along the direction of travel passing the feature of interest.

In an aspect, for each of the consists, all of the propulsion-generating vehicles in the consist are de-rated during an entire time period that the consist is traveling over the feature of interest even if the consist is without any of the de-rating vehicles that are subject to the handling rule associated with the feature of interest, and none of the propulsion-generating vehicles in the vehicle system are de-rated during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

In an aspect, for each of the consists, all of the propulsion-generating vehicles in the consist are de-rated during an entire time period that the consist is traveling over the feature of interest only if the consist includes at least one of the de-rating vehicles that is subject to the handling rule associated with the feature of interest.

In an aspect, none of the propulsion-generating vehicles in the vehicle system are de-rated during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

In an aspect, each of the de-rating vehicles that is subject to the handling rule is de-rated during an entire time period that the de-rating vehicle travels over the feature of interest without de-rating the propulsion-generating vehicles that are not subject to the handling rule.

In an aspect, the propulsion-generating vehicles that are not subject to the handling rule are operated using the larger range of throttle settings during travel over the feature of interest.

In an aspect, the vehicle system comprises one or more non-propulsion-generating vehicles, and wherein none of the propulsion-generating vehicles in the vehicle system are de-rated during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

In an embodiment, a system (e.g., a control system) includes an identification apparatus, a location determination apparatus, and a control apparatus. The identification apparatus is configured to determine which propulsion-generating vehicles in a vehicle system having plural interconnected propulsion-generating vehicles are de-rating vehicles that are subject to a handling rule associated with a feature of interest in a route to be traveled or being traveled by the vehicle system. The handling rule dictates that throttle settings of the de-rating vehicles be limited to a reduced range of throttle settings when the de-rating vehicles travel over or through the feature of interest in the route. The reduced range of throttle settings is a smaller range of throttle settings that the de-rating vehicles are permitted to use relative to a larger range of throttle settings that the de-rating vehicles are permitted to use when traveling on the route outside of the feature of interest. The location determination apparatus is configured to determine when one or more of the propulsion-generating vehicles are at least one of approaching or at the feature of interest. The control apparatus is configured to operate the de-rating vehicles using the larger range of throttle settings when the de-rating vehicles are traveling along the route and outside of the feature of interest. The control apparatus also is configured to automatically de-rate at least a subset of the propulsion-generating vehicles in the vehicle system by operating the propulsion-generating vehicles in the at least a subset using the smaller range of throttle settings during travel over the feature of interest.

In an aspect, the control apparatus is configured to automatically terminate de-rating of the at least a subset of the propulsion-generating vehicles upon completion of travel over the feature of interest in the route.

In an aspect, the feature of interest includes at least one of a crossing between the route and at least an additional route or a bridge along the route.

In an aspect, the propulsion-generating vehicles are arranged in two or more consists in the vehicle system and the consists each includes at least one of the propulsion-generating vehicles. The consists are separated from each other by one or more non-propulsion-generating vehicles in the vehicle system.

In an aspect, the control apparatus is configured to control all of the propulsion-generating vehicles in the vehicle system using the smaller range of throttle settings during an entire time period that begins with a first consist along a direction of travel of the vehicle system reaching the feature of interest and that ends with a last consist along the direction of travel passing the feature of interest.

In an aspect, for each of the consists, the control apparatus is configured to de-rate all of the propulsion-generating vehicles in the consist during an entire time period that the consist is traveling over the feature of interest even if the consist is without any of the de-rating vehicles that are subject to the handling rule associated with the feature of interest, and none of the propulsion-generating vehicles in the vehicle system are de-rated during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

In an aspect, for each of the consists, the control apparatus is configured to de-rate all of the propulsion-generating vehicles in the consist during an entire time period that the consist is traveling over the feature of interest only if the consist includes at least one of the de-rating vehicles that is subject to the handling rule associated with the feature of interest.

In an aspect, the control apparatus is configured to de-rate none of the propulsion-generating vehicles in the vehicle system during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

In an aspect, the control apparatus is configured to de-rate each of the de-rating vehicles that is subject to the handling rule during an entire time period that the de-rating vehicle travels over the feature of interest without de-rating the propulsion-generating vehicles that are not subject to the handling rule.

In an aspect, the control apparatus is configured to control the propulsion-generating vehicles that are not sub-
ject to the handling rule using the larger range of throttle settings during travel over the feature of interest.

In an aspect, the vehicle system comprises one or more non-propulsion-generating vehicles and the control apparatus is configured to de-rate none of the propulsion-generating vehicles in the vehicle system during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

In an embodiment, a method (e.g., for controlling de-rating of a vehicle consist) includes automatically controlling throttle settings of a rail vehicle consist as the rail vehicle consist travels along a track. The rail vehicle consist has a lead vehicle consist and at least one remote vehicle consist that each include one or more propulsion-generating rail vehicles and that are connected with each other by one or more non-propulsion-generating rail vehicles disposed between the lead vehicle consist and the at least one remote vehicle consist. The method also includes de-rating the propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist are traveling over a designated track feature. The propulsion-generating rail vehicles are de-rated by limiting the throttle settings of the propulsion-generating rail vehicles to a designated first maximum throttle level that is less than a second maximum throttle level that the propulsion-generating rail vehicles are controlled to when not traveling over the designated track feature. The method further includes de-rating the propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist while the one or more non-propulsion-generating rail vehicles are traveling over the designated track feature but not de-rating the propulsion-generating vehicles in each of the lead vehicle consist and the at least one remote vehicle consist after a last of the at least one remote vehicle consist, in a direction of travel of the rail vehicle consist, has passed over the designated track feature.

In an embodiment, a method (e.g., for controlling de-rating of a vehicle consist) includes automatically controlling throttle settings of a rail vehicle consist as the rail vehicle consist travels along a track. The rail vehicle consist has a lead vehicle consist and at least one remote vehicle consist that each include one or more propulsion-generating rail vehicles and that are connected with each other by one or more non-propulsion-generating rail vehicles disposed between the lead vehicle consist and the at least one remote vehicle consist. Automatically controlling the throttle settings of the rail vehicle consist comprises automatically de-rating the propulsion-generating rail vehicles in at least one of a first, second, third, or fourth mode of operation. The first mode of operation involves the propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist being automatically de-rated while the lead vehicle consist and the at least one remote vehicle consist are traveling over a designated track feature. The propulsion-generating rail vehicles are de-rated by limiting the throttle settings of the propulsion-generating rail vehicles to a designated first maximum throttle level that is less than a second maximum throttle level that the propulsion-generating rail vehicles are controlled to when not traveling over the designated track feature. The propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist are automatically de-rated while the one or more non-propulsion-generating rail vehicles are traveling over the designated track feature. The second mode of operation involves all the propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist being automatically de-rated only while the lead vehicle consist and the at least one remote vehicle consist are traveling over the designated track feature but not while the one or more non-propulsion-generating rail vehicles are traveling over the designated track feature. The third mode of operation involves, for each of the lead vehicle consist and the at least one remote vehicle consist, all the propulsion-generating rail vehicles in each of the lead vehicle consist being automatically de-rated but only if at least one of the propulsion-generating rail vehicles in the consist is designated for operation at no more than the designated first maximum throttle level when traveling over the designated track feature. The fourth mode of operation involves, while the vehicle consist is traveling over the designated track feature, only those propulsion-generating rail vehicles in the consist that are designated for operation at no more than the designated first maximum throttle level when traveling over the designated track feature being automatically de-rated.

In any of the embodiments herein: (i) the lowest throttle setting of a reduced range of throttle settings may be greater than power-off or idle; (ii) in the case of a designated first maximum throttle level that is less than a second maximum throttle level, the designated first maximum throttle level may be greater than a power-off or idle throttle level; (iii) a feature of interest and/or a designated track feature is a location or length of route that a rail vehicle consist or other vehicle system traverses at a non-zero velocity; and/or (iv) references to a particular class or segmentation/grouping of consist or vehicle, in the context of a larger consist or vehicle system, may refer to only some of such particular class or segmentation of consist or vehicle, or each and every one of such particular class or segmentation.

It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) may be used in combination with each other. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the inventive subject matter without departing from its scope. While the dimensions and types of materials described herein are intended to define the parameters of the inventive subject matter, they are by no means limiting and are exemplary embodiments. Many other embodiments will be apparent to one of ordinary skill in the art upon reviewing the above description. The scope of the inventive subject matter should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms “including” and “in which” are used as the plain-English equivalents of the respective terms “comprising” and “wherein.” Moreover, in the following claims, the terms “first,” “second,” and “third,” etc. are used merely as labels, and are not intended to impose numerical requirements on their objects. Further, the limitations of the following claims are not written in means-plus-function format and are not intended to be interpreted based on 35 U.S.C. §112, sixth paragraph, unless and until such claim limitations expressly use the phrase “means for” followed by a statement of function void of further structure.

This written description uses examples to disclose several embodiments of the inventive subject matter and also to enable a person of ordinary skill in the art to practice the embodiments of the inventive subject matter, including mak-
The foregoing description of certain embodiments of the inventive subject matter will be better understood when read in conjunction with the appended drawings. To the extent that the figures illustrate diagrams of the functional blocks of various embodiments, the functional blocks are not necessarily indicative of the division between hardware circuitry. Thus, for example, one or more of the functional blocks (for example, processors or memories) may be implemented in a single piece of hardware (for example, a general purpose signal processor, microcontroller, random access memory, hard disk, and the like). Similarly, the programs may be stand-alone programs, may be incorporated as subroutines in an operating system, may be functions in an installed software package, and the like. The various embodiments are not limited to the arrangements and instrumentality shown in the drawings.

As used herein, an element or step recited in the singular and proceeded with the word “a” or “an” should be understood as not excluding plural of said elements or steps, unless such exclusion is explicitly stated. Furthermore, references to “one embodiment” of the inventive subject matter are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features. Moreover, unless explicitly stated to the contrary, embodiments “comprising,” “including,” or “having” an element or a plurality of elements having a particular property may include additional such elements not having that property.

Since certain changes may be made in the above-described systems and methods without departing from the spirit and scope of the inventive subject matter herein involved, it is intended that all of the subject matter of the above description or shown in the accompanying drawings shall be interpreted merely as examples illustrating the inventive concept herein and shall not be construed as limiting the inventive subject matter.

1. A method comprising:
   identifying a feature of interest in a route to be traveled or being traveled by a vehicle system having plural propulsion-generating vehicles;
   identifying one or more of the propulsion-generating vehicles as de-rating vehicles that are subject to a handling rule associated with the feature of interest, the handling rule dictating that throttle settings of the de-rating vehicles be limited to a reduced range of throttle settings when the de-rating vehicles travel over or through the feature of interest in the route, the reduced range of throttle settings being a smaller range of throttle settings that the de-rating vehicles are permitted to use when traveling on the route outside of the feature of interest;
   when the de-rating vehicles are traveling along the route and outside of the feature of interest, operating the de-rating vehicles using the larger range of throttle settings; and
   responsive to at least one of the propulsion-generating vehicles in the vehicle system at least one of approaching or traveling over the feature of interest, automatically de-rating at least a subset of the propulsion-generating vehicles in the vehicle system by operating the at least a subset of the propulsion-generating vehicles using the smaller range of throttle settings during travel over the feature of interest.

2. The method of claim 1, wherein automatically de-rating the at least a subset of the propulsion-generating vehicles terminates upon completion of travel over the feature of interest in the route.

3. The method of claim 1, wherein the feature of interest includes at least one of a crossing between the route and at least an additional route or a bridge along the route.

4. The method of claim 1, wherein the propulsion-generating vehicles are arranged in two or more consists in the vehicle system, the consists each including at least one of the propulsion-generating vehicles, the consists separated from each other by one or more non-propulsion-generating vehicles in the vehicle system.

5. The method of claim 4, wherein automatically de-rating the at least a subset of the propulsion-generating vehicles in the vehicle system includes operating all of the propulsion-generating vehicles in the vehicle system using the smaller range of throttle settings during an entire time period that begins with a first consist along a direction of travel of the vehicle system reaching the feature of interest and that ends with a last consist along the direction of travel passing the feature of interest.

6. The method of claim 4, wherein, for each of the consists, all of the propulsion-generating vehicles in the consist are de-rated during an entire time period that the consist is traveling over the feature of interest even if the consist is without any of the de-rating vehicles that are subject to the handling rule associated with the feature of interest, and wherein none of the propulsion-generating vehicles in the vehicle system are de-rated during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

7. The method of claim 4, wherein, for each of the consists, all of the propulsion-generating vehicles in the consist are de-rated during an entire time period that the consist is traveling over the feature of interest only if the consist includes at least one of the de-rating vehicles that is subject to the handling rule associated with the feature of interest.

8. The method of claim 7, wherein none of the propulsion-generating vehicles in the vehicle system are de-rated during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

9. The method of claim 1, wherein each of the de-rating vehicles that is subject to the handling rule is de-rated during an entire time period that the de-rating vehicle travels over the feature of interest without de-rating the propulsion-generating vehicles that are not subject to the handling rule.

10. The method of claim 9, wherein the propulsion-generating vehicles that are not subject to the handling rule are operated using the larger range of throttle settings during travel over the feature of interest.
11. The method of claim 9, wherein the vehicle system comprises one or more non-propulsion-generating vehicles, and wherein none of the propulsion-generating vehicles in the vehicle system are de-rated during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

12. A system comprising:

an identification apparatus configured to determine which propulsion-generating vehicles in a vehicle system having plural interconnected propulsion-generating vehicles are de-rating vehicles that are subject to a handling rule associated with a feature of interest in a route to be traveled or being traveled by the vehicle system, the handling rule dictating that throttle settings of the de-rating vehicles be limited to a reduced range of throttle settings when the de-rating vehicles travel over or through the feature of interest in the route, the reduced range of throttle settings being a smaller range of throttle settings that the de-rating vehicles are permitted to use relative to a larger range of throttle settings that the de-rating vehicles are permitted to use when traveling on the route outside of the feature of interest;

a location determination apparatus configured to determine when one or more of the propulsion-generating vehicles are at least one of approaching or at the feature of interest; and

a control apparatus configured to operate the de-rating vehicles using the larger range of throttle settings when the de-rating vehicles are traveling along the route and outside of the feature of interest, the control apparatus also configured to automatically de-rate at least a subset of the propulsion-generating vehicles in the vehicle system by operating the propulsion-generating vehicles in the at least a subset using the smaller range of throttle settings during travel over the feature of interest.

13. The system of claim 12, wherein the control apparatus is configured to automatically terminate de-rating of the at least a subset of the propulsion-generating vehicles upon completion of travel over the feature of interest in the route.

14. The system of claim 12, wherein the feature of interest includes at least one of a crossing between the route and at least an additional route or a bridge along the route.

15. The system of claim 12, wherein the propulsion-generating vehicles are arranged in two or more consists in the vehicle system, the consists each including at least one of the propulsion-generating vehicles, the consists separated from each other by one or more non-propulsion-generating vehicles in the vehicle system.

16. The system of claim 15, wherein the control apparatus is configured to control all of the propulsion-generating vehicles in the vehicle system using the smaller range of throttle settings during an entire time period that begins with a first consist along a direction of travel of the vehicle system reaching the feature of interest and that ends with a last consist along the direction of travel passing the feature of interest.

17. The system of claim 15, wherein, for each of the consists, the control apparatus is configured to de-rate all of the propulsion-generating vehicles in the consist during an entire time period that the consist is traveling over the feature of interest even if the consist is without any of the de-rating vehicles that are subject to the handling rule associated with the feature of interest, and none of the propulsion-generating vehicles in the vehicle system are de-rated during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

18. The system of claim 15, wherein, for each of the consists, the control apparatus is configured to de-rate all of the propulsion-generating vehicles in the consist during an entire time period that the consist is traveling over the feature of interest only if the consist includes at least one of the de-rating vehicles that is subject to the handling rule associated with the feature of interest.

19. The system of claim 18, wherein the control apparatus is configured to de-rate none of the propulsion-generating vehicles in the vehicle system during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

20. The system of claim 12, wherein the control apparatus is configured to de-rate each of the de-rating vehicles that is subject to the handling rule during an entire time period that the de-rating vehicle travels over the feature of interest without de-rating the propulsion-generating vehicles that are not subject to the handling rule.

21. The system of claim 20, wherein the control apparatus is configured to control the propulsion-generating vehicles that are not subject to the handling rule using the larger range of throttle settings during travel over the feature of interest.

22. The system of claim 20, wherein the vehicle system comprises one or more non-propulsion-generating vehicles, and wherein the control apparatus is configured to de-rate none of the propulsion-generating vehicles in the vehicle system during times when the one or more non-propulsion-generating vehicles in the vehicle system are traveling over the feature of interest.

23. A method comprising:

automatically controlling throttle settings of a rail vehicle consist as the rail vehicle consist travels along a track, the rail vehicle consist having a lead vehicle consist and at least one remote vehicle consist that each include one or more propulsion-generating rail vehicles and that are connected with each other by one or more non-propulsion-generating rail vehicles disposed between the lead vehicle consist and at least one remote vehicle consist;

de-rating the propulsion-generating rail vehicles in each of the lead vehicle consist and at least one remote vehicle consist while the lead vehicle consist and the at least one remote vehicle consist are traveling over a designated track feature, the propulsion-generating rail vehicles de-rated by limiting the throttle settings of the propulsion-generating rail vehicles to a designated first maximum throttle level that is less than a second maximum throttle level that the propulsion-generating rail vehicles are controlled to when not traveling over the designated track feature; and

de-rating the propulsion-generating rail vehicles in each of the lead vehicle consist and at least one remote vehicle consist while the one or more non-propulsion-generating rail vehicles are traveling over the designated track feature but not de-rating the propulsion-generating rail vehicles in each of the lead vehicle consist and the at least one remote vehicle consist after a last of the at least one remote vehicle consist, in a direction of travel of the rail vehicle consist, has passed over the designated track feature.
24. A method comprising:
automatically controlling throttle settings of a rail vehicle
consist as the rail vehicle consist travels along a track,
the rail vehicle consist having a lead vehicle consist and
at least one remote vehicle consist that each include one
or more propulsion-generating rail vehicles and that are
connected with each other by one or more non-propul-
sion-generating rail vehicles disposed between the lead
vehicle consist and the at least one remote vehicle con-
sist;
wherein automatically controlling the throttle settings of
the rail vehicle consist comprises automatic operation of
the rail vehicle consist in at least one of the following
modes:
a first mode of operation wherein the propulsion-generat-
ing rail vehicles in each of the lead vehicle consist and
the at least one remote vehicle consist are automatically
de-rated while the lead vehicle consist and the at least
one remote vehicle consist are traveling over a desig-
nated track feature, the propulsion-generating rail
vehicles de-rated by limiting the throttle settings of the
propulsion-generating rail vehicles to a designated first
maximum throttle level that is less than a second maxi-
mum throttle level that the propulsion-generating rail
vehicles are controlled to when not traveling over the
designated track feature, and the propulsion-generating
rail vehicles in each of the lead vehicle consist and the at
least one remote vehicle consist being automatically
de-rated while the one or more non-propulsion-generat-
ing rail vehicles are traveling over the designated track
feature;
a second mode of operation wherein all the propulsion-
generating rail vehicles in each of the lead vehicle con-
sist and the at least one remote vehicle consist are auto-
matically de-rated only while the lead vehicle consist
and the at least one remote vehicle consist are traveling
over the designated track feature but not while the one or
more non-propulsion-generating rail vehicles are trav-
eling over the designated track feature;
a third mode of operation wherein for each of the lead
vehicle consist and the at least one remote vehicle con-
sist, all the propulsion-generating rail vehicles in the
consist are automatically de-rated but only if at least one
of the propulsion-generating rail vehicles in the consist
is designated for operation at no more than the desig-
nated first maximum throttle level when traveling over
the designated track feature; or
a fourth mode of operation wherein while the vehicle con-
sist is traveling over the designated track feature, only
those propulsion-generating rail vehicles in the consist
that are designated for operation at no more than the
designated first maximum throttle level when traveling
over the designated track feature are automatically de-
rated.

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