The disclosure is directed to a communication system (44) for a consist (10) having a locomotive (12) and a tender car (14). The communication system may have a locomotive access (46) point configured to be located onboard the locomotive, a locomotive controller (48) connected to the locomotive access point, a tender car access point (46) configured to be located onboard the tender car, and a tender car controller (48) connected to the tender car access point. The communication system may also have at least one network component (50) configured to be located onboard the locomotive or the tender car and connected with a corresponding one of the locomotive and tender car access points, and a communication coupling (20) extending between the locomotive and tender car access points. The locomotive and tender car controllers may be configured to selectively affect operation of the locomotive and tender car, respectively, based on operational information obtained via the at least one network component.
Description

LOCOMOTIVE/TENDER CAR COMMUNICATION SYSTEM

Technical Field

The present disclosure relates generally to a communication system and, more particularly, to a system for communication between a locomotive and a tender car.

Background

A consist includes one or more locomotives, and in some instances a tender car, that are coupled together to produce motive power for a train of rail vehicles. The locomotives each include one or more engines, which combust fuel to produce mechanical power. The engine(s) of each locomotive can be supplied with liquid fuel (e.g., diesel fuel) from an onboard tank, gaseous fuel (e.g., natural gas) from the tender car, or a blend of the liquid and gaseous fuels. The mechanical power produced by the combustion process is directed through a generator and used to generate electricity. The electricity is then routed to traction motors of the locomotives, thereby generating torque that propels the train. The locomotives can be connected together at the front of the train or separated and located at different positions along the train. For example, individual locomotives can be located at either end of the tender car, and the consist can be positioned at the front, middle, or end of the train. In some instances, more than one consist may be included within a single train.

Because the locomotives of a consist must cooperate to propel the train, communication between the locomotives and/or between the locomotives and the tender car can be important. Historically, this communication has been facilitated through the use of an MU (Multi-Unit) cable that extends along the length of the consist. An MU cable is comprised of many different wires, each capable of carrying a discrete signal used to regulate a different aspect of consist operation. For example, a lead locomotive generates current within a particular one of the wires to indicate a power level setting requested by the train operator. When this wire is energized, the engines of all locomotives are caused to operate at a specific throttle value. In another example, when one locomotive
experiences a fault condition, another of the wires is energized to alert the other locomotives of the condition's existence.

Although acceptable in some applications, the information traditionally transmitted via the MU cable may be insufficient in other application. For example, during the fault condition described above, it can be important to know a severity and/or cause of the fault condition so that an appropriate response to the fault condition can be implemented in an effective and efficient manner. Additionally, as consist configurations become more complex, for example during multi-unit blended fuel operations (i.e., operations where gaseous fuel from the tender car is simultaneously supplied to multiple locomotives and mixed with diesel fuel at different rates), control of the locomotives and/or the tender car may require a greater amount of cooperation and/or more complex communication than can be provided via the MU cable.

One attempt to address the above-described problems is disclosed in U.S. Patent Publication 2010/0241295 of Cooper et al. that published on September 23, 2010 ("the '295 publication"). Specifically, the '295 publication discloses a consist having a lead locomotive and one or more trail locomotives connected to each other via an MU cable. Each locomotive includes a computer unit, which, along with the MU cable, forms an Ethernet network in the train. With this configuration, network data can be transmitted from the computer unit in the lead locomotive to the computer units in the trail locomotives. The network data includes data that is packaged in packet form as data packets and uniquely addressed to particular computer units. The network data can be vehicle sensor data indicative of vehicle health, commodity condition data, temperature data, weight data, and security data. The network data is transmitted orthogonal to conventional non-network (i.e., command) data that is already being transmitted on the MU cable.

While the consist of the '295 publication may have improved communication between locomotives, it may still be less than optimal. In particular, the disclosed consist may not have an effect on control over tender car/locomotive operations.

The system of the present disclosure solves one or more of the problems set forth above and/or other problems with existing technologies.
Summary

In one aspect, the disclosure is directed to a communication system for a consist having a locomotive and a tender car. The communication system may include a locomotive access point configured to be located onboard the locomotive, a locomotive controller connected to the locomotive access point, a tender car access point configured to be located onboard the tender car, and a tender car controller connected to the tender car access point. The communication system may also have at least one network component configured to be located onboard the locomotive or the tender car and connected with a corresponding one of the locomotive and tender car access points, and a communication coupling extending between the locomotive and tender car access points. The locomotive and tender car controllers may be configured to selectively affect operation of the locomotive and tender car, respectively, based on operational information obtained via the at least one network component.

In another aspect, the disclosure is directed to another communication system having a plurality of locomotives and a tender car. This communication system may include a locomotive access point configured to be located onboard each of the plurality of locomotives, a locomotive controller connected to each locomotive access point, a tender car access point configured to be located onboard the tender car, and a tender car controller connected to the tender car access point. The communication system may also include a plurality of network components configured to be located onboard the plurality of locomotives or the tender car and connected with a corresponding one of the locomotive and tender car access points, and a communication coupling extending between the locomotive and tender car access points. The locomotive and tender car controllers may be configured to selectively affect operation of the plurality of locomotives and the tender car, respectively, based on operational information obtained via the plurality of network components over the communication coupling.
Brief Description of the Drawings

Fig. 1 is a pictorial illustration of an exemplary disclosed consist; and

Fig. 2 is a diagrammatic illustration of an exemplary disclosed communication system that may be used in conjunction with the consist of Fig. 1.

Detailed Description

Fig. 1 illustrates an exemplary train consist 10 having one or more locomotives 12 and a tender car 14. In the disclosed embodiment, consist 10 has three different locomotives 12, including a lead locomotive 12a located ahead of tender car 14 and two trailing locomotives 12b, 12c located behind tender car 14. It is contemplated, however, that consist 10 may include any number of locomotives 12 and/or tender cars, and that locomotives 12 may be located in any arrangement relative to tender car(s) 14 and in any orientation (e.g., forward-facing or rear-facing). Consist 10 may be located at the front of a train of other rail vehicles (not shown), within the train of rail vehicles, or at the end of the train of rail vehicles. It is also contemplated that more than one consist 10 may be included within a single train of rail vehicles, if desired, and/or that consist 10 may travel at times without a train of other rail vehicles.

Each locomotive 12 may be connected to an adjacent locomotive 12 and/or tender car 14 in several different ways. For example, locomotives 12 and tender car 14 may be connected to each other via a mechanical coupling 16, one or more fluid couplings 18, and one or more electrical couplings 20. Mechanical coupling 16 may be configured to transmit tractive and braking forces between locomotives 12 and tender car 14. Fluid couplings 18 may be configured to transmit fluids (e.g., fuel, coolant, lubrication, pressurized air, etc.) between locomotives 12 and tender car 14. Electrical couplings 20 may be configured to transmit power and/or data (e.g., data in the form of electrical signals) between locomotives 12 and tender car 14. In one example, electrical couplings 20 include an MU cable configured to transmit conventional command signals and/or electrical power. In another example, electrical couplings 20 include a dedicated data link configured to transmit packets of data (e.g.,
Ethernet data), as will be discussed in more detail below. In yet another example, the data packets may be transmitted via the MU cable. It is also contemplated that some data may be transmitted between locomotives 12 and tender car 14 via a combination of the MU cable, the dedicated data link, and/or other means (e.g., wirelessly), if desired.

Each locomotive 12 may include a car body 22 supported at opposing ends by a plurality of trucks 24 (e.g., two trucks 24). Each truck 24 may be configured to engage a track (not shown) via a plurality of wheels, and to support a frame 26 of car body 22. Any number of engines 28 may be mounted to frame 26 within car body 22 and drivingly connected to a generator 30 to produce electricity that propels the wheels of each truck 24. Engines 28 may be internal combustion engines configured to combust a mixture of air and fuel. The fuel may include a liquid fuel (e.g., diesel) provided to engines 28 from a tank 32 located onboard each locomotive 12, a gaseous fuel (e.g., natural gas) provided by tender car 14 via fluid couplings 18, and/or a blended mixture of the liquid and gaseous fuels.

Tender car 14, like locomotives 12, may also be equipped with a frame 26 that is supported by two or more trucks 24. Tender car 14 may also include one or more tanks 34 mounted to its frame 26 that are configured to store liquefied gaseous fuel (e.g., liquefied natural gas or LNG). The liquefied gaseous fuel may be gasified and then fed in series or parallel to all locomotives 12 of consist 10 for combustion within engines 28. In the disclosed embodiment, a single insulated tank 34 is used to store the liquefied gaseous fuel at low temperatures, such as below about -160°C. In some embodiments, tank 34 may be integral with frame 26 of tender car 14.

Additional fuel delivery components may be associated with tender car 14 and used to gasify and/or transport the fuel from tender car 14 to locomotives 12. These components may include, among other things, one or more fuel pumps 36, one or more heat exchangers 38, one or more accumulators 40, one or more regulators 42, and associated conduits (not shown) that condition, pressurize or otherwise move fuel, as is known in the art.

Pump(s) 36 may be situated near or within tank 34, and embody, for example, cryogenic pumps, piston pumps, centrifugal pumps, or any other pumps that are known in the industry. Pumps 36 may primarily be powered with
electricity supplied via couplings 20 from generators 30 located onboard locomotives 12 (e.g., onboard lead locomotive 12a). Additionally or alternatively, pumps 36 may be powered by an electric storage system and/or an onboard auxiliary engine (not shown), if desired. Pumps 36 may pressurize the liquefied gaseous fuel to a desired operating pressure and push the fuel through heat exchanger(s) 38 to accumulator(s) 40. Heat exchanger(s) 38 may provide heat sufficient to gasify the fuel as it moves therethrough. Upon vaporization, the fuel may be transported to and stored within accumulator(s) 42. Although shown as being located onboard only tender car 14, it is contemplated that some or all of accumulator(s) 42 could alternatively be located onboard each locomotive 12. Gaseous fuel may be directed to engines 28 via regulator(s) 42.

As shown in Fig. 2, consist 10 may be equipped with a communication system 44 that facilitates coordinated control of locomotives 12 and tender car 14. Communication system 44 may include, among other things, an access point 46 for each locomotive 12 and for tender car 14. Each access point 46 may be connected to one or more wired and/or wireless networks, and used to communicate command signals and/or data between controllers 48 of each rail vehicle and various other network components (e.g., sensor, valves, pumps, heat exchangers, accumulators, regulators, actuators, etc.) 50 that are used to control locomotives 12 and/or tender car 14. Access points 46 may be connected to each other via electrical couplings 20 (e.g., via the MU cable, via the dedicated data link, and/or wirelessly).

Each access point 46 may include a processor, a router & bridge, an MU modem, input/output (I/O) ports, a storage, a memory, and any other conventional components known in the art. The I/O ports may facilitate communication between the associated access point 46 and one or more of network components 50. Likewise, the MU modem may facilitate communication between different access points 46 connected to each other via electrical couplings 20. The router & bridge may be configured to route data packets between the processor and the I/O ports and/or between the processor and the MU modem. For example, when a particular access point 46 receives data packets from corresponding I/O ports and/or from the MU modem, the router & bridge may route the data packets to the processor.
The processor may include one or more processing devices, such as microprocessors and/or embedded controllers. The storage may include volatile or non-volatile, magnetic, semiconductor, tape, optical, removable, non-removable, or other type of computer-readable medium or computer-readable storage device. The storage may be configured to store programs and/or other information that may be used to implement one or more of the processes discussed below. The memory may include one or more storage devices configured to store information used by the associated access point 46.

Each controller 48 may be configured to control operational aspects of its related rail vehicle. For example, controller 48 of lead locomotive 12a may be configured to control operational aspects of its corresponding engine 28, generator 30, traction motors, operator displays, and other associated components. Likewise, the controllers 48 of trail locomotives 12b and 12c may be configured to control operational aspects of their corresponding engines 28, generators 30, traction motors, operator displays, and other associated components. In some embodiments, controller 48 of lead locomotive may be further configured to control operational aspects of trail locomotives 12b and 12c, if desired. Controller 48 of tender car 14 may be configured to control operational aspects of pump(s) 36, heat exchanger(s) 38, accumulator(s) 40, regulator(s) 42, and other associated tender car components.

Each controller 48 may embody a single microprocessor or multiple microprocessors that include a means for controlling an operation of the associated rail vehicle based on information obtained from any number of network components 50 and/or communications received via access points 46. Numerous commercially available microprocessors can be configured to perform the functions of controller 48. Controller 48 may include a memory, a secondary storage device, a processor, and any other components for running an application. Various other circuits may be associated with controller 48 such as power supply circuitry, signal conditioning circuitry, solenoid driver circuitry, and other types of circuitry.

The information obtained by a particular controller 48 via access points 46 and/or network components 50 may include performance related data associated with operations of each locomotive 12 and/or tender car 14 ("operational information"). For example, the sensory data could include engine
related parameters (e.g., speeds, temperatures, pressures, flow rates, etc.),
generator related parameters (e.g., speeds, temperatures, voltages, currents, etc.),
operator related parameters (e.g., desired speeds, desired fuel settings, locations, 
destinations, braking, etc.), liquid fuel related parameters (e.g., temperatures,
consumption rates, fuel levels, demand, etc.), gaseous fuel related parameters
(e.g., temperatures, supply rates, fuel levels, etc.), and other parameters known in
the art. The performance related data may be data sensed via individual sensors
of network components 50 and/or data that is calculated based on assumed or
measured parameters.

The information obtained by a particular controller 48 via access
points 46 and/or network components 50 may also include identification data of
the other rail vehicles within the same consist 10. For example, each controller
48 may include stored in its memory the identification of the particular rail
vehicle with which controller 48 is associated. The identification data may
include, among other things, a type of rail vehicle (e.g., make, model, and unique
identification number), physical attributes of the associated rail vehicle (e.g.,
size, load limit, volume, power output, power requirements, fuel consumption
capacity, fuel supply capacity, etc.), and maintenance information (e.g.,
maintenance history, time until next scheduled maintenance, usage history, etc.).
When coupled with other rail vehicles within a particular consist 10, each
controller 48 may be configured to communicate the identification data to the
other controllers 48 within the same consist 10. Each controller 48, as will be
described in more detail below, may be configured to selectively affect operation
of its own rail vehicle based on the obtained identification data associated with
the other rail vehicles of consist 10.

In some embodiments, controllers 48 may each be configured to
affect operation of their associated rail vehicles based on the information
obtained via access points 46 and/or network components 50 and one or more
maps stored in memory. Each of these maps may include a collection of data in
the form of tables, graphs, and/or equations. Some of these operations will be
described in more detail in the following section.

In some instances, it may be beneficial to export operational
information to an offboard entity 52. In particular, lead locomotive 12a (or
another rail vehicle of the associated consist 10) may be equipped with a
communication device 54 connectable with controller 48. Communication
device 54 may be configured to communicate messages wirelessly between
controller 48 and offboard entity 52. The wireless communications may include
satellite, cellular, infrared, and any other type of wireless communication.
Offboard entity 52 may be, for example, service personnel, and the
communications may include messages regarding fault conditions, identification
of failed components, and/or instructions for the service personnel. It is
contemplated that other information may also be transmitted offboard, if desired.

Industrial Applicability

The disclosed communication system may be applicable to any
consist having at least one locomotive and a tender car that is coupled with the
locomotive. The communication system may enhance cooperation between the
locomotive and the tender car by facilitating complex communication of data
that affects fuel use and fuel supply. Exemplary operations of communication
system 44 will now be described in detail.

As disclosed above, during or after coupling of different rail
vehicles within a particular consist 10, controllers 48 of each rail vehicle may
begin to communicate with each other via electrical couplings 20. For example,
controller 48 of tender car 14 may communicate with each controller 48 of
locomotives 12 via the existing MU cable. This communication may include the
exchange of identification information. For instance, controller 48 of tender car
14 may provide the other controllers 48 of each locomotive 12 with an
identification of tender car 14 as a tender car of a particular make and model.
Controller 48 of tender car 14 may additionally communicate a maximum fuel
volume, a fuel supply capacity, an electrical power requirement, a maintenance
history, and other information to locomotives 12. In some instances, controllers
48 of locomotives 12 may already know some of this information based on the
make and model of tender car 14. Likewise, controllers 48 of locomotives 12
may transmit similar information to tender car 14 at this same time.

In some embodiments, controllers 48 of the different rail vehicles
may adjust operation of their associated rail vehicles based on the identification
information. For example, it may be possible that one or more rail vehicles of
particular makes and models are not compatible with each other. And after the
exchange of identification information, an alert may be generated indicative of
the situation. In another example, it may be possible for a particular locomotive
12 (or group of locomotives 12) to normally demand a fuel supply rate during a
particular throttle setting that exceeds an established capacity of tender car 14 to
supply fuel. In this situation and based on the identification information,
controllers 48 of one or more of locomotives 12 may be configured to selectively
scale future fuel supply demands while connected with the particular tender car
14. For the purposes of this disclosure, scaling may be considered a reduction or
increase in a demand for fuel from for particular engine 28 according to one or
more scale factors stored in memory and associated with particular makes and/or
models of tender cars 14. Alternatively, controllers 48 of one or more of
locomotives 12 may be configured to selectively use different fuel blend ratios.
It may also be possible for controllers 48 of locomotives 12 to reduce a fuel
supply load on tender car 14 (or for controller 48 of tender car 14 to reduce a rate
of fuel supply to a particular locomotive 12) based on a maintenance history or
another identification parameter (e.g., when a particular rail vehicle is nearing a
required maintenance interval).

During operation of consist 10, controllers 48 may be configured
to further adjust operation of their associated rail vehicles based on performance
data communicated between controllers 48 over the MU cable. For example,
during a fault condition, different actions can be taken depending on which rail
vehicle is generating the fault condition and what the fault condition is.
Specifically, it may be possible for tender car 14 to generate fault conditions of
different criticality. The fault conditions can be generated manually or
automatically based on one or more conditions sensed by network components
50 (e.g., based on a fuel level, a temperature, a pressure, a flow rate, a manually-
pressed cutoff switch, etc.). When the fault condition from tender car 14 is a
non-critical fault condition, controllers 48 of locomotives 12 may simply log the
fault condition without further action being taken. However, when a more
serious fault condition is communicated via electrical coupling 20, controllers 48
could alert the train operator, communicate the condition offboard to entity 52,
reduce a consist speed and/or torque, adjust the blend ratio of fuels consumed by
engines 28 (i.e., reduce or increase consumption of gaseous fuel from tender car
14), cause brakes to be applied, and/or implement other evasive maneuvers. The
reverse may also be true, wherein controller 48 of tender car 14 selectively adjusts operation of pump 36, heat exchanger 38, accumulator 40, and/or regulator 42 based on fault conditions from controllers 48 of locomotives 12 (e.g., based on fault conditions that are triggered from sensed speeds, temperatures, pressures, etc. of engines 28, generator 30, and/or associated wheel traction motors).

In some situations, it may be possible to generate the fault conditions based on communications between controller 48 of tender car 14 and controllers 48 of locomotives 12. For example, network components 50 of a particular locomotive 12 may be capable of sensing or otherwise calculating a fuel consumption rate of an associated engine 28 (e.g., based on a measured flow rate, a measured speed of engine 28, a fuel setting, etc.). Likewise, network components 50 of tender car 14 may be capable of sensing or otherwise calculating a rate of fuel supply to the engine 28 (e.g., based on a measured flow rate, a measured speed and/or pressure of pump 36, etc.). This information may then be communicated between rail vehicles via electrical coupling 20 and, based on the information, one or more of controllers 48 may be able to detect a significant difference between the fuel consumption and supply rates that is indicative of a fuel leak. When this occurs, a corresponding fault condition may be triggered causing operational adjustments of one or more of the rail vehicles.

In another example, during a non-fault condition (i.e., during normal operation), controllers 48 may still be configured to adjust operation of their associated rail vehicles based on performance data communicated between controllers 48. For example, operation of locomotives 12 and/or tender car 14 may be adjusted based on the changing level of fuel within tanks 32 of locomotives 12 and/or within tank 34 of tender car 14. There are many reasons for doing so and many ways in which this can be done. Several exemplary situations are provided below.

In a first situation, it may be possible for locomotives 12 to have different amounts of liquid fuel stored onboard within tanks 32 at any given time. For example, tank 32 of lead locomotive may be nearly full of diesel fuel, while tank 32 of trail locomotive 12b may be half full, and tank 32 of trail locomotive 12c may be one-quarter full. In an ideal situation, for emission purposes, each engine 28 of locomotives 12 should be supplied with about the
same blend of diesel fuel and natural gas. However, such operation could cause trail locomotive 12c to completely consume its supply of diesel fuel long before the other locomotives 12 consume their supplies. In this situation, it may be better for lead locomotive 12a to operate with a higher diesel fuel blend and for trail locomotive 12c to operate with a higher natural gas blend, such that all locomotives 12 can operate for an extended period of time. Accordingly, based on fuel levels sensed by network components 50 that are communicated between controllers 48 via access points 46 and electrical coupling 20 (e.g., via the MU cable), each controller 48 may selectively adjust the operation of its own associated rail vehicle. The blend rate of fuel may be adjusted by changing an amount of diesel fuel supplied to each engine 28 via control over onboard fuel supply components and/or by changing an amount of natural gas provided to each engine 28 from tender car 14 via control over pump 36, heat exchanger 38, accumulator 40, and/or regulator 42.

In a second and related situation, the amount of natural gas stored within tank 34 of tender car 14 relative to the amounts of diesel fuel contained within tanks 32 onboard locomotives 12 may be insufficient for the expected duration of an intended trip at a desired fuel blend ratio. After communicating fuel level information between locomotives 12 and tender car 14, one or more of controllers 48 may determine the need to adjust the fuel blend such that the desired destination may be reached with the available fuel.

In a third situation, it may be more efficient for a locomotive 12 located immediately adjacent to tender car 14 (e.g., trail locomotive 12b) to run at a higher natural gas blend than for a locomotive 12 located further away from tender car 14 (e.g., lead locomotive 12a). The improved efficiency may be something that is sensed via network components 50, calculated by one or more of controllers 48, and/or simply known based on past experience. Regardless of the way in which the improved efficiency is determined, any one or all of controllers 48 may be configured to selectively adjust the blend rates of fuel supplied to any one or more of engines 28.

In a fourth situation, it may be better for the engines 28 of particular locomotives 12 to be loaded to a higher or lower degree than other engines 28. For example, a particular engine 28 may operate more efficiently when under a heavier load, as compared to a different engine 28. Similarly, a
particular engine 28 may operate at a more desirable temperature under a given load. Other operational differences may also exist, and these communicated differences may be sensed via network components 50, calculated by controllers 48, or simply known based on past experience, and then communicated between controllers 48. And based on any of these differences, it may be desirable to selectively direct more or less natural gas from tender car 14 to a particular engine 28 of a particular locomotive 12.

In a fifth situation, the demand for natural gas by a particular locomotive 12 may simply change during a single trip and, unless the changing demand is communicated to tender car 14, conditions of tender car 14 may not be appropriate to comply with the change in demand. Specifically, when controller 48 of a particular locomotive 12 communicates a change in demand for natural gas to controller 48 of tender car 14, controller 48 of tender car 14 may respond by adjusting operation of its associated supply components. For example, controller 48 of tender car 14 may adjust operation of pump 36, heat exchanger 38, accumulator 40, and/or regulator 42 based on the performance information from locomotives 12 such that tender car 14 can supply natural gas at the demanded level. It is contemplated that, in some instances, the change in demand may be anticipated and communicated to controller 48 of tender car 14 in advance such that tender car 14 is immediately capable of supplying natural gas at the higher or lower rate when the new demand is received. The change in demand may be anticipated based on known changes in terrain, known restrictions on train speed at particular geographic locations, and other known factors.

In a sixth and related situation, communication between tender car 14 and locomotives 12 may have an effect on when locomotives 12 change their demand for natural gas. For example, it may be possible for controllers 48 of locomotives 12 to request a higher or lower supply rate of natural gas, without yet commanding their associated engines 28 to operate any differently. In response to the requested change in supply rate, controller 48 of tender car 14 may adjust operation of pump 36, heat exchanger 38, accumulator 40, and/or regulator 42 in the manner described above. After making these adjustments, controller 48 of tender car 14 may then inform controllers 48 of locomotives 12 that tender car 14 is ready to supply natural gas at the higher or lower rate.
Controllers 48 of locomotives 12 may be configured to only then command engines 28 to operate differently.

In a seventh situation, it may be possible for a particular locomotive controller 48 to request a supply of natural gas from tender car 14 at a rate that exceeds the capability of its associated engine 28 to consume the natural gas. For example, based on pressures, temperatures, speeds, or other conditions sensed by network components 50 from onboard the particular locomotive 12, controller 48 of tender car 14 may be able to determine that the requested supply rate of fuel is too much. In this situation, controller 48 of tender car 14 may be able to selectively reduce the supply rate. Similarly, it may be possible for a particular locomotive controller 48 to request a supply of natural gas from tender car 14 at a rate that exceeds the immediate capability of tender car 14 to supply the fuel. In this situation, controller 48 of tender car 14 may be able to request that the demand rate be temporarily reduced until tender car 14 is capable of increasing its supply rate.

The disclosed communication system may improve control over tender car/locomotive operations. Specifically, the enhance ability to communicate identification and operational information between tender car 14 and locomotives 12 may allow consist 10 to operate more efficiently and more responsively. That is, tender car 14 may be more capable of supplying gaseous fuel to locomotives 12 in a manner and at a timing most beneficial to locomotives 12. At the same time, locomotives 12 may be more capable of adjusting their own operations to accommodate current operations and/or limitations of tender car 14. As a result, consist 10 may be have improved performance.

It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed system without departing from the scope of the disclosure. Other embodiments of the system will be apparent to those skilled in the art from consideration of the specification and practice of the system disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims and their equivalents.
What is claimed is:

1. A communication system (44) for a consist (10) having a locomotive (12) and a tender car (14), the communication system comprising:
   a. a locomotive access point (46) configured to be located onboard the locomotive;
   b. a locomotive controller (48) connected to the locomotive access point;
   c. a tender car access point (46) configured to be located onboard the tender car;
   d. a tender car controller (48) connected to the tender car access point;
   e. at least one network component (50) configured to be located onboard the locomotive or the tender car and connected with a corresponding one of the locomotive and tender car access points; and
   f. a communication coupling (20) extending between the locomotive and tender car access points,

   wherein the locomotive and tender car controllers are configured to selectively affect operation of the locomotive and tender car, respectively, based on operational information obtained via the at least one network component.

2. The communication system of claim 1, wherein:
   a. the at least one network component is configured to be located onboard the locomotive; and
   b. the tender car controller is configured to selectively affect operation of the tender car based on operational information obtained via the at least one network component.

3. The communication system of claim 1, wherein:
   a. the at least one network component is configured to be located onboard the tender car; and
   b. the locomotive controller is configured to selectively affect operation of the locomotive based on operational information obtained via the at least one network component.

4. The communication system of claim 1, wherein:
the at least one network component includes:
at least a first network component configured to be located
onboard the tender car; and
at least a second network component (50) configured to be
located onboard the locomotive;
the locomotive controller is configured to selectively affect
operation of the locomotive based on operational information obtained via the at
least a first network component; and
the tender car controller is configured to selectively affect
operation of the tender car based on operational information obtained via the at
least a second network component.
5. The communication system of claim 4, wherein:
the at least a first network component includes a first plurality of
network components; and
the at least a second network component includes a second
plurality of network components.
6. The communication system of claim 1, wherein the at
least one network component includes at least one of a temperature sensor,
pressure sensor, speed sensor, fuel level sensor, actuator, valve, pump, heat
exchanger, accumulator, or regulator.
7. The communication system of claim 1, wherein the
communication coupling is a multi-unit cable.
8. The communication system of claim 7, wherein the
operational information is communicated over the communication coupling as
Ethernet data.
9. The communication system of claim 1, wherein the
locomotive and tender car controllers are configured to selectively affect
operation of the locomotive and tender car, respectively, based further on
identification information communicated between the locomotive and tender car
controllers via the communication coupling.
10 The communication system of claim 1, wherein the
locomotive controller is configured to affect at least one of a fuel demand of an
engine located onboard the locomotive, a blend rate of fuel consumed by the
engine, a speed of the engine, and a load of the engine.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

B61G 5/06(2006.01)i, B61C 17/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B61G 5/06; G06F 19/00; B61C 5/00; G05D 1/00; G06F 7/00; B61C 17/02; B60T 8/34; B61C 17/12; B61C 17/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: consist, locomotive, tender car, communication, access point, controller, MU cable, data, and operational information

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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Date of the actual completion of the international search
13 October 2014 (13.10.2014)

Date of mailing of the international search report
13 October 2014 (13.10.2014)

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