DATA COMMUNICATION APPARATUS, SYSTEM, AND METHOD

Background

Machine to machine communication is becoming increasingly important to the energy, communications, and security markets, among others. Supervisory Control and Data Acquisition (SCADA) systems used in those industries rely on inputs from remotely located sensors to function properly. SCADA systems can also output signals to actuate remote equipment in the field. A sizeable portion of that equipment (~18% for U.S. electric utilities) is located underground, and providing wireless communications between above ground and underground equipment is a serious challenge.

Current methods used to locate underground cable faults are still slow and labor intensive. Even relatively short outages can be used against utilities and lead to rate adjustments for customers, so a faster means of locating and fixing underground faults is needed.

Thus, there is a need for communicating wireless signals into and out of underground equipment vaults and other structures where underground equipment is located.

Summary of the Invention

In one aspect of the invention, a data communication system comprises a transceiver including active electronics, an antenna, and GPS circuitry, disposed on a metal entrance port to an underground enclosure, the transceiver including a housing, the housing mountable to the metal entrance port, wherein the transceiver is configured to communicate with a network outside of the underground enclosure. The data communication system also includes a monitoring device disposed in the underground enclosure that provides data related to a real-time condition within the underground enclosure. The data communication system also includes a sensor analytics unit to process the data from the monitoring device and generate a processed data signal and to communicate the processed data signal to the transceiver.

In another aspect, the sensor detects at least one of: power, voltage, current, temperature, combustible materials or byproducts of combustion, mechanical strain,

mechanical movement, humidity, soil condition, pressure, hazardous atmosphere, liquid flow, leakage, component end-of-life or lifetime, personnel presence, physical state, light level, and vibration. In a further aspect, the sensor is incorporated in a sensored cable accessory and is configured to monitor a condition of a power cable.

In yet another aspect, the sensor analytics unit includes a digital signal processor. In another aspect, the sensor analytics unit includes a wireless network communications chip.

In another aspect, the transceiver unit includes a hardened above ground antenna and radio. In another aspect, the transceiver is configured to send aggregated information upstream to another aggregation node or cloud server above ground. In a further aspect, the aggregated data comprises one or more of periodic status notification and asynchronous alarm notification.

In another aspect, the entrance port comprises a manhole cover. In a further aspect, the transceiver is secured to the manhole cover and a portion of the transceiver housing extends through a hole formed in the entrance cover. In yet another aspect, the transceiver housing portion extending through the hole formed in the entrance cover is substantially flush with a top surface of the entrance cover.

In another aspect, the entrance port comprises a manhole cover and a ring portion to receive the manhole cover, wherein the transceiver is secured to the ring portion of the entrance port.

In another aspect, the data communication system further comprises a power harvesting device coupled to at least one power line located in the underground enclosure. In another aspect, the power harvesting device is coupled to the sensor analytics unit and provides power to the sensor analytics unit.

In another aspect of the invention, a data communication system comprises a transceiver including active electronics, an antenna, and GPS circuitry, disposed on metal entrance port to an underground enclosure. The transceiver includes a housing mountable to the entrance port, wherein the transceiver is configured to communicate with a network outside of the underground enclosure. The system also includes a sensored cable accessory mounted to a power line located in the underground enclosure, the sensored cable accessory including a sensor that measures data related to a real-time condition within the underground enclosure. The sensored cable accessory also

includes a signal processing chip to process the measured data and a communication chip to communicate processed data to the transceiver.

In another aspect, the sensored cable accessory further comprises a power harvesting device coupled to the power line to provide power to the signal processing chip and communication chip.

In another aspect of the invention, a data communication system comprises a transceiver including active electronics, an antenna, and GPS circuitry, disposed on a metal portion of an underground enclosure containing utility equipment, the transceiver including a housing, the housing mountable to the underground enclosure, wherein the transceiver is configured to communicate with a network outside of the underground enclosure. The system also includes a monitoring device, such as a sensor, disposed in the underground enclosure that provides data related to a real-time condition within the underground enclosure. The system also includes a sensor analytics unit to process the data from the monitoring device and generate a processed data signal and to communicate processed data signal to the transceiver.

In another aspect, the enclosure comprises an underground vault. In a further aspect, the enclosure comprises a grade level or above-ground enclosure.

The above summary of the present invention is not intended to describe each illustrated embodiment or every implementation of the present invention. The figures and the detailed description that follows more particularly exemplify these embodiments.

Brief Description of the Drawings

The invention will be described hereinafter in part by reference to non-limiting examples thereof and with reference to the drawings, in which:

Fig. 1 is a schematic view of a data communication system according to a first aspect of the invention.

Figs. 2A- 2E are side views of alternative transceiver mountings and constructions according to other aspects of the invention.

Fig. 3 is a schematic view of a data communication system according to another aspect of the invention.

Claims

1. A data communication system, comprising:

a transceiver including active electronics, an antenna, and GPS circuitry, disposed on a metal entrance port to an underground enclosure, the transceiver including a housing, the housing mountable to the metal entrance port, wherein the transceiver is configured to communicate with a network outside of the underground enclosure;

a monitoring device disposed in the underground enclosure that provides data related to a real-time condition within the underground enclosure; and

a sensor analytics unit to process the data from the monitoring device and generate a processed data signal and to communicate the processed data signal to the transceiver.

2. The data communication system of claim 1, wherein the monitoring device comprises a sensor.

3. The data communication system of claim 2, wherein the sensor detects at least one of: power, voltage, current, temperature, combustible materials or byproducts of combustion, mechanical strain, mechanical movement, humidity, soil condition, pressure, hazardous atmosphere, liquid flow, leakage, component end-of-life or lifetime, personnel presence, physical state, light level, and vibration.

4. The data communication system of claim 1, wherein the transceiver includes a communications gateway unit.

5. The data communication system of claim 1, wherein the sensor analytics unit includes a digital signal processor

6. The data communication system of claim 1, wherein the sensor analytics unit includes a wireless network communications chip.

7. The data communication system of claim 1, wherein the transceiver unit includes a hardened above ground antenna and radio.

8. The data communication system of claim 1, wherein the transceiver is configured to send aggregated information upstream to another aggregation node or cloud server above ground.

9. The data communication system of claim 1, wherein the transceiver is configured to respond to messages sent to it by an upstream aggregation node or cloud.

10. The data communication system of claim 1, wherein the entrance port comprises a manhole cover and a ring portion to receive the manhole cover.

11. The data communication system of claim 10, wherein the transceiver is secured to the manhole cover and a portion of the transceiver housing extends through a hole formed in the entrance cover.

12. The data communication system of claim 11, wherein the transceiver housing portion extending through the hole formed in the entrance cover is substantially flush with a top surface of the entrance cover.

13. The data communication system of claim 10, wherein the transceiver is secured to a ring portion of the entrance port.

14. The data communication system of claim 1, further comprising a power harvesting device coupled to at least one power line located in the enclosure.

15. The data communication system of claim 1, wherein the sensor analytics unit contains a plurality of interface ports configured to connect to one or more environmental sensors.

16. A data communication system, comprising:

a transceiver including active electronics, an antenna, and GPS circuitry, disposed on a metal entrance port to an underground enclosure, the transceiver including a housing, the housing mountable to the entrance port, wherein the transceiver is configured to communicate with a network outside of the underground enclosure; and

a sensored cable accessory mounted to a power line located in the underground enclosure, the sensored cable accessory including a sensor that measures data related to a real-time condition within the underground enclosure, a signal processing chip to process the measured data, and a communication chip to communicate processed data to the transceiver.

17. The data communication system of claim 16, wherein the sensored cable accessory further comprises a power harvesting device coupled to the power line to provide power to the signal processing chip and communication chip.

18. A data communication system, comprising:

a transceiver including active electronics, an antenna, and GPS circuitry, disposed on a metal portion of an underground enclosure containing utility equipment, the transceiver including a housing, the housing mountable to the underground enclosure, wherein the transceiver is configured to communicate with a network outside of the underground enclosure;

a monitoring device disposed in the underground enclosure that provides data related to a real-time condition within the underground enclosure; and

a sensor analytics unit to process the data from the monitoring device and generate a processed data signal and to communicate the processed data signal to the transceiver.

19. The data communication system of claim 17, wherein the enclosure comprises an underground vault.

20. The data communication system of claim 17, wherein the enclosure comprises a grade level or above-ground enclosure.