stand-alone sensor, instrumentation system, GPS receiver, and Iridium modem and antenna, all in one sealed buoy.

Beam Communications Iridium 9602SBD Modem, describes a modem similar to that used in one embodiment of the present invention. This modem is touted as the most compact Iridium modem available, with a built-in 9-32V DC power supply.

JouBeh Technologies discloses a compact 9602SBD Iridium transceiver and describes a modem similar to that used in one embodiment of the present invention. This modem is touted as the most compact Iridium modem available, with an built-in 9-32V DC power supply.

NAL Standard Modems discloses standard Iridium modems.

New Pathfinder Technology for Ice—Ocean System Monitoring (National Snow and Ice Data Center) discloses an instrument package for monitoring glaciers as well as sea ice and the ocean.

Technical Workshop, Application of Iridium Telecommunications to Oceanographic and Polar Research, (University of Washington Applied Physics Laboratory, 2004) discloses a number of applications for Iridium technology in remote sensing applications. Note the Iridium data module with GPS (page 12).

Architecture of a Satellite-Based Sensor Network for Environmental Observation, (Wei Ye) discloses the use of satellite linked remote sensors for environmental measurements.

InterOcean Systems, Inc., Remote Environmental Monitoring and Data Collection Systems discloses a number of buoy products for environmental monitoring. Note the discussion of a "modular design" on page 1, although there does not appear to be any description of the modules themselves.

While the Prior Art discloses a number of integrated data acquisition systems for use in data buoys, weather stations, and the like, a need remains in the art for an inexpensive, reliable, and easy way to add sensors or other features to such data acquisition stations, without disturbing the underlying electronics, systems, and communications systems in the data acquisition station. In addition, a need exists in the art for a standardized packaged smart sensor module, that can be applied singly, or in a configuration of multiple modules, to allow for flexible configuration of remote data acquisition systems.

SUMMARY OF THE INVENTION

The present invention provides a small, very low power, building block type module that may be used to interface new sensors, or conduct testing of new processing schemes without heavy system development, test, and costs typically encountered in modifying the larger more complex system. In addition, the small very low-power device contains core functions of data collection, processing, and communication. Thus, it can be repurposed to other uses, such as backup to other functions (e.g., GPS position reporting and environmental data transmission and control from shore). It contains readily available wireless communication components. Several of these devices may be organized into a wireless sensor and communications network.

The present invention includes a device which measures data signals, receives data streams, records, processes, and communicates data via wireless links, from remote ocean locations to shore based systems or other nearby communication systems. It combines commercially available electronic parts, operating system and enclosure with a custom circuit board and firmware. One uniqueness feature is the combination of Commercial Off-The-Shelf (COTS) components, satellite services, real time operating system and custom firmware to accomplish data acquisition and reporting needs not readily and commercially available or as economical.

The present invention includes a data collector, processor, transmitter, location reporting, and data storage device which provides bi-directional satellite communications anywhere in the world. The combination uses very little power and is economical as compared to other devices. It may be used for many unattended remote data collection and reporting needs. In one embodiment, the present invention may be used to measure and report remote marine data for marine weather analysis, forecasts, and warnings. The device may include wired and/or wireless connections to interface with sensors, a user, or other devices.

The present invention has a number of applications and methods of use. In one embodiment, the device may be attached to a data buoy or other data collection system, to add additional sensor capabilities, without having to disturb existing sensor equipment. Existing data buoys are often designed as a sensor package, and if additional sensors were added to such a package, the entire system would need to be modified and tested to insure that the additional sensors and software does not create conflicts with other sensors. By providing a "stand alone" packaged sensor solution, the present invention may be readily installed in an existing data buoy, with minimal labor and materials costs, and without disturbing existing sensors, data processors, and communications systems.

The present invention has other applications as well, including as a back-up system, which may be readily installed when other systems fail. It may also be used to provide a back up locator if a data buoy fails or is dislodged. In a fail-safe mode, the system of the present invention can upload a GPS location to an IRIDIUM satellite every day for nearly three years, on battery power.

In addition, the device of the present invention may be used in a modular arrangement, where multiple devices may communicate with one another in wired or wireless modes. The device may be used as a Smart End Device, to log data from a sensor or sensors. Another device, communicating wirelessly or in wired mode, with one or more Smart End Devices, may serve as a Smart Coordinator, accumulating data from other Smart End Devices and uploading the packaged data via satellite modem. In order to reduce the number of different module types in the field, the smart modules of the present invention may be provided with similar or identical hardware, and then programmed in the field to act as Smart End Devices (logging data from sensors) and Smart Coordinators (accumulating data from Smart End Devices) and uploading the data via satellite. In this manner, the inventory of different device types is reduced, and redundant capabilities are provided in the field. If one smart module fails in whole or in part, another module may be configured, even remotely, to take over chores of the failed module.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded view of one embodiment of the apparatus of the present invention.

FIG. **2** is a block diagram illustrating the major components in one embodiment of the present invention.

FIG. **3**A is a perspective view of the smart sensor module, illustrating installation on an existing weather data buoy.

FIG. **3**B illustrates the smart module of the present invention as mounted to the data buoy of FIG. **3**A.