MAR PB200 weather instrument, as illustrated in FIG. 3A. The Smart Weather Station provides a compact weather station, which may be installed on a platform to acquire and report base meteorological data in situations where no other weather system is available (e.g., destroyed buoy mast, or inoperative non repairable systems encountered in the field).

The Smart Weather Station (SWS) is constructed as illustrated in FIG. 3B. The AIRMAR PB200 **340** and Smart Module **130** are functionally tested and then the two are then integrated, configured (via user port **145**), and tested in a blue tag type test to verify readiness. The system is started by simply connecting power. The SWS then enters a "deployment mode" which acquires data for four minutes then transmits a standard NDBC (National Buoy Data Center) formatted message to shore. This cycle is repeated again at a five-minute boundary, five more times. Thus in total, six transmissions are sent at five minutes apart. Depending on the startup time, the first report may not contain data due to the short time to the five-minute boundary. The SWS then exits deployment mode after 30 minutes. Data is then acquired and reported hourly. In "buoy mode" this is minute 42 to 50 followed by an immediate transmission. In C-MAN mode, this is minute 58 to 00, followed by an immediate transmission.

If the battery input voltage falls below 9.5V, the SWS enters a fail-safe mode where data collection and reporting stops. In this mode, it will use its internal 9V battery pack to acquire and report a GPS position once per day. The pack will last three years with one report per day. If system power returns, the SWS will complete the deployment mode again and then acquisition and reporting operation.

Other SWS capabilities include 32 GB of internal storage of raw time series data and engineering level system debug information, back channel (shore to SWS) interface to reconfigure the SWS for longer reporting intervals, or any of its many configuration parameters. One TAO battery canister **330** (two lithium packs) is used to power the SWS for one year when configured for hourly reporting.

The SWS is designed to mount on three-meter and six-meter buoys. FIG. 3A illustrates a 3-meter buoy **310**. The SWS (less the battery pack) mounting hole matches the anemometer mount. The battery box **330** installs on the upper mast of a three-meter buoy **310** near the beacon light and matches existing hole-patterns. The SWS **130** and battery box **330** have mounting brackets that can be strapped to any floating structure using stainless steel tie-wraps or u-bolts, or other appropriate means. The exact method used will be determined by the field service team at the particular buoy. In general, the SWS should be installed as high as possible above the buoy deck (like anemometers) and away from metal obstructions over the enclosure lid; or else the Iridium antenna, under the lid, will be blocked and transmissions will fail. The platform condition, sea state, and available ship time may force other options to be used.

The smart module of the present invention may be used as a standalone interface for non-governmental sensors or systems. In some situations, an external customer or agency may desire to install a sensor on a buoy and report data in real time. The Smart Module of the present invention may be used to create a combination to interface private sensors without modifying existing National Weather Service, Climate, or Tsunami warning systems. Alternately, such private data may be passed through a Smart Module Coordinator, and transmitted, along with weather data, to shore.

The smart module of the present invention may be applied to other applications, such as the Wave Glider autonomous self-powered buoy. The wave glider may provide power from onboard systems, and the smart module may fit in the spare area (called the "payload") of the glider. External antenna access may need to be provided, as the "payload" area is behind the glider solar panels, which would likely block RF signals to the Iridium satellite.

The apparatus and methods of the present invention may be applied to other applications, in addition to weather data buoys and the likes. The smart module of the present invention may also be marketed as-is or in a slightly modified configuration as portable weather station for enthusiasts in the general public. For example, a smart weather station module may be configured to communicate data from a remote home weather station to a home computer, smart phone, or other device, via a home wi-fi network

Similarly, a network of smart sensors may be installed across farms to better allocate water resources, or in severe weather zones to help monitor tornadic, derecho, and other severe weather activity.

While disclosed in the context of weather data, the apparatus and methods of the present invention may also be applied to security and industrial applications such as biohazard monitoring, motion sensors, security cameras, and other types of data and security sensors, without departing from the spirit and scope of the present invention.

While the preferred embodiment and various alternative embodiments of the invention have been disclosed and described in detail herein, it may be apparent to those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope thereof.

I claim:

1. A sensor module for accumulating, processing and transmitting sensor data, comprising:

a data input for receiving sensor data from at least one instrument, and formatting the sensor data as digital sensor data,

a processor, coupled to the data input, configured to process and store the digital sensor data in memory, and packaging digital sensor data for transmission to a remote data system; and

a satellite communication modem, coupled to the processor and the internal antenna, receiving packaged digital sensor data and transmitting the packaged digital sensor data to the remote data system,

wherein the data input further including one or more of:

a first analog input configured to receive analog sensor data from at least one external sensor, a signal conditioning circuit receiving the analog sensor data and conditioning the analog sensor data, and an analog-to-digital converter, coupled to the signal conditioning circuit, configured to convert conditioned analog sensor data into digital sensor data, and

a first digital input configured to receive one or more of digital sensor data from an external sensor and user control data from a user, wherein the processor, coupled to the analog-to-digital converter and the first digital input, is configured to process and store the digital sensor data in memory, and packaging digital sensor data for transmission to a remote data systems;

wherein a sensor module may be configured through one or more of user control data from the first digital input and memory of the processor, to configure a sensor module in at least one of a plurality of modes,

wherein in a first mode, where the at least one sensor module is configured as a smart module coordinator, receiving digital sensor data from at least one other sensor module, storing digital sensor data from the at least one other sensor module, packaging digital sensor