Woods Hole Oceanographic Institution

Upper Ocean Processes Group

Technical Note

Buoy Telemetry

December 2005

Argos on UOP Buoys

Since the 1980s, the Upper Ocean Processes (UOP) Group has used Argos telemetry on surface buoys to monitor meteorological and sea-surface parameters as well as buoy positions.

Our meteorological system controller, the ASIMet logger, is designed to communicate directly with an Argos Platform Transmitter Terminal (PTT). The logger sends 32-byte messages to the PTT, the maximum length that Argos can currently handle. We can count on a minimum of seven Argos satellite passes per day at any of our buoy sites, though pass frequency varies with latitude. To minimize data gaps, we use three Argos ids per ASIMet logger, with a rolling buffer that handles six records at a time. Because of the throughput constraints, we transmit hourly averages, and data values are encoded at a lower resolution than the instruments' internally recorded data. To save more space in the transmitted records, some parameters, such as wind gust, scalar wind speed and direction, are not included in the Argos data transmission.

Data messages received by the Argos satellites are collected at their processing center in Maryland and delivered every six hours via ftp to a workstation at our lab in Woods Hole, where they are processed by a set of automated scripts and Matlab programs, with data displayed on our website in near-real-time.

At sea, we use an AlphaOmega (AO) Satellite Receiver to collect the Argos messages in real-time. The AO software logs incoming messages to disk on a laptop computer; we process the messages in Matlab in real-time to assess data quality and to compare buoy instruments with shipboard sensors.

The Argos system also provides Doppler buoy positions, which we monitor via the web with Matlab-generated maps. Although the position information is accurate to only about 1000 m, it is sufficient for determining if a buoy has broken anchor and for tracking moving buoys. An emergency transmitter is also mounted under each buoy, designed to begin transmitting only in the event that a buoy turns over.

For data transmissions, we use Seimac Wildcat or Smartcat PTTs, which fit inside the cases of our ASIMet loggers. Power is supplied by a stack of D-cells, and patch antennae are mounted on the buoy towers. The PTTs are programmed to broadcast nearly continuously, retransmitting the same messages for a full hour between data updates from the loggers, as there is no verification of receipt of messages from the Argos satellites.

This system has provided us with enough near-real-time data to adequately monitor our sensors and buoy positions, but has some limitations. Issues that we have encountered with the Argos system include occasional throughput problems with individual transmitters, network failures requiring manual intervention or interrupting service, RF interference from PTTs affecting some sensors, and cost of service, which constrains our bandwidth. Further, because there are currently only six Argos satellites, there is a significant lag in acquiring data from our buoys.

Additional bandwidth is needed to allow transmission of higher precision and higher data rate meteorological parameters and of subsurface water velocity and temperature data. Additional sensors planned for the ASIMet loggers, including GPS systems, and other packages on the buoys all require more throughput. We also see the eventual need for two-way communications to allow changes in sample rate or other event-driven control over deployed instruments.

The next generation of Argos telemetry, Argos-III, will address some of these issues, with the potential for two-way communication and increased record lengths. The data lag will continue to be a problem, however, limiting our ability to effectively provide event-driven, user-initiated instrument control. As a possible alternative solution, UOP is now also developing Iridium communication capability for our buoys.

Iridium Communications

On a buoy deployed at the Hawaii Ocean Time Series Site (WHOTS) in July, 2005, one of the two ASIMet loggers is equipped with a newly designed Iridium communications module, in addition to the standard Argos PTT. The Iridium module is a prototype, and for this implementation it is transmitting hourly averages of surface data only. This test was funded by NOAA's Office of Climate Observations through the Cooperative Institute for Climate and Ocean Research (CICOR) program.

The Iridium module includes a modem, a Linux-based embedded computer, and power control and regulator boards. The modem, a 9522 L-Band Transceiver (LBT), is an NAL Research Model A3LA-D. It is designed for data use, and comes equipped with an antenna connector and a DB-25 serial interface; the DB-25 interface integrates power control and RS232 communications in one connection to the ASIMet logger.

The Linux-based embedded computer is an Intrinsyc Cerfboard 255, based on an Intel PXA255 Xscale Strongarm processor. In the current configuration, the Cerfboard gets one-minute data from the ASIMet logger, stores it to a compact flash card, and preprocesses it for transmission. At pre-set intervals, it powers up the Iridium modem, waits for registration with a satellite, sends data, and waits for an acknowledgement before powering down the modem.

The Cerfboard power is controlled by the ASIMet logger, so power is used only at intervals pre-set in the logger. Error handling, retries, data processing and formatting are all programmable on the Cerfboard, limited only by total power consumption and available batteries on the buoy.

Communication Protocol

Our Iridium transmission scheme uses a protocol called Short Burst Data (SBD), which allows messages up to 1960 bytes from the buoy. Message receipt is acknowledged back to the buoy, so Argos-style continuous transmission is unnecessary. Our Iridium SBD service is currently provided by Global Information Technologies, based in Cedar Park, Texas.

Messages are forwarded across the Iridium satellite network utilizing inter-satellite links to reach the Iridium gateway. From the gateway, they are forwarded as Base64 MIME-encoded binary attachments to email messages, sent to a virtual email account at WHOI. Messages are received every four hours. These are downloaded using Mozilla Thunderbird, and processed with Matlab. Plans include automating the extraction of the data attachments using a Perl program.

Power and Throughput

The current one-minute buoy data records are 64 bytes each, so two 1960-byte SBD messages would be required to send an hour of one-minute records. In lab tests, the approximate time to send a 1960-byte SBD message is 25 seconds, from power up to completion, including about 15 seconds to start up and acquire satellites, and 8.5 seconds to transmit each message. Since two such messages could be sent in about 32 seconds, about 12 minutes per day of on-time would be required to transmit one-minute data once per hour for a real-time data stream at the instrument's full record rate. At about a 1.5 AH power consumption rate, two long 120 AH D-cell alkaline packs would easily run the Iridium module for a 400-day buoy deployment.

Remaining Issues

We have not yet designed a shipboard system for receiving and monitoring Iridium SBD messages during mooring deployment cruises. We will need a replacement for the position information currently supplied by Argos, for which GPS systems are being investigated. Also to be determined is a replacement system for our emergency position beacon, currently provided by a special-purpose Argos transmitter mounted under the buoy hull. These issues make it likely that we will continue to use Argos for at least some of our telemetry needs for several years.

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