Wavix Fuses Aerospace Technology and Operational Oceanography

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The oceanographic data market includes commercial firms, governments, and research institutions involved in the collection, transmission, or analysis of oceanographic data. The data are used to enhance decision-making, improve oceanographic- and marine-related products and services, and for scientific and engineering research. Recently, this market has been exhibiting significant growth. Oil and gas operations are now occurring in water depths that previously had been considered technically unfeasible and uneconomic, and there is increasing scientific and social interest in Global Climate Change research.

These marketplace changes have spawned a new concept in oceanographic data collection: "Operational Oceanography", the idea of large-scale programs of data collection that operate independently from the users of the data. Until now, the users of the data typically developed their own buoy program at great expense and use of scarce internal resources. In the new era of Operational Oceanography, resources are shared and used more efficiently, so that much more data can be collected and analyzed by more users.

Remote Communications

A major impediment in this emerging market is the lack of an affordable communication infrastructure. Current data transmission services are not optimized for oceanographic data use and do not meet current and future needs. A relatively high-volume, low-cost communications system with two-way capability is required. Although some applications demand real-time transmissions, the majority of the market only requires what we refer to as "real-enough time" data: data received on the same day in which it was collected, which is appropriately timely for most purposes.

Two-way communication is an improvement of particular interest to oceanographers; commands can be sent to the buoy to recover from failures or to change experiment parameters in response to interesting phenomena. This type of interactivity will become more critical as expanding Global Climate Change research creates new opportunities for research which will require significantly greater volumes of oceanographic data.

Until very recently, the Argos or GOES satellite systems were the sole means of retrieving timely remote data. However, throughput is limited to a few thousand bytes of data per day; a complete data set has to wait for physical retrieval of the buoy. The newly developed low-Earth orbiting (LEO) satellite services such as Orbcomm, Iridium, and Globalstar are designed for millions of users with very short messages, thus providing either very limited data rates or charging extravagantly for the volumes of oceanographic data required. The geosynchronous satellites, such as Inmarsat and Intelsat, are designed for real-time transmissions at much higher throughput than is

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needed and are, as a result, prohibitively expensive.

Wavix: A Unique Partnership

Wavix, Incorporated is a start-up company formed in response to these changes and opportunities in the oceanographic marketplace. Its products include oceanographic and meteorological data, data transmission services using its proprietary satellite communication system, and special-purpose buoys for oceanographic data collection.

Wavix represents a unique melding of diverse capabilities: an established satellite manufacturer, a pioneer in the use of LEO satellites for humanitarian purposes, a premier oceanographic research institution, and an expert in aerospace technologies – resulting in a company positioned to develop this new market niche with a combination of advanced technologies. Wavix was born of a successful NASA Small Business Technology Transfer collaboration between Jackson and Tull (J&T), an aerospace engineering company, and the Woods Hole Oceanographic Institution (WHOI), one of the largest independent marine research organizations in the world. J&T and WHOI continue as technology partners in the venture.

Wavix developed WavSat, its 2-way satellite-based communication system, in cooperation with Volunteers in Technical Assistance (VITA) and SatelLife, two non-profit organizations, and with Surrey Satellite Technology, LTD (SSTL). VITA assists the people of developing countries in improving their lives by providing access to technical and other kinds of information. For their pioneering use of LEO satellites, they have been awarded two operational licenses by the FCC. SatelLife is an international organization serving the health communication and information needs of developing countries. SatelLife has a LEO satellite, HealthSat-2, currently on orbit and operational. HealthSat-2 was built by SSTL, a leader in microsatellite technology, having launched 14 LEO satellites in the past 20 years.

Through an innovative arrangement, VITA, SatelLife, and Wavix have pooled resources in a three-way agreement by which communications capacity will be available to Wavix while VITA will retain capacity for use as part of a satellite consortium. Developed in collaboration with SatelLife, this consortium is devoted to using satellites for health, humanitarian, and development purposes in developing countries. SatelLife and VITA retain free access to the communications capacity of HealthSat-2 and of future Wavix satellites, which will also be part of the consortium. As the commercial anchor-tenant for this satellite system, Wavix is providing the monetary foundation for this very important humanitarian mission. Wavix will soon have access to a second satellite manufactured by SSTL to further expand its WavSat constellation.

Operational Oceanography

Wavix provides its customers with a complete, end-to-end, interactive ocean-observing system, leaving them free to concentrate on their scientific or engineering questions rather than wasting their resources on deploying, maintaining, and retrieving buoys. By concentrating on providing data rather than hardware, Wavix provides its customers with excellent value.

Wavix works closely with individual customers to discover their project's unique measurement needs. Wavix then assumes responsibility for implementing the program and delivering a steady stream of high-quality, calibrated data to the customer. As needed, the customer can exploit the command link to the remote mooring and reprogram it, with Wavix's assistance, to respond to unexpected measurement needs or opportunities or to recover from failures.

Wavix maintains its own moorings and outfits them with a standard set of fully calibrated and documented sensors. Special-purpose sensors for unusual experiments can be easily accommodated. The buoys are deployed and serviced by Wavix, who also monitors the returned data stream for scientific integrity and performs level-0 processing (applying instrument normalization).

Data from each location are returned several times daily in real-enough time, with an average latency of 1.5 hours, to the Wavix Data Center for processing, archiving, and distribution. Each customer's data are available soon after it reaches the Data Center, whence they can be delivered electronically via the Internet on a time scale and in a format that suits each customer's needs.

Technological Advances

Shortly after its formation in January 1999, Wavix was recognized by NASA for its innovative development efforts with a 1999 NASA Space Act Award, a program providing recognition of contributions that have helped to achieve NASA's aeronautical, commercialization, and space goals.

Perhaps the most significant advance incorporated in the Wavix system is WavSat, its two-way satellite communications system, specifically designed to support the oceanographic community. WavSat can transmit about 500KB of data per day back to the researcher from each remote location. WavSat operates with two LEO satellites in near polar orbits operating in the UHF/VHF bands.

The Wavix buoy has a modular design so that the suite of sensors and the data-gathering software can be easily reconfigured for a variety of scientific experiments. The buoy mooring features new technology developed at WHOI: a highly compliant elastic tether, with coiled signal conductor, that can maintain tension even in swells approaching 50% of water depth without being pulled under water, significantly increasing the reliability and survivability of the buoy.

The buoy's highly flexible data system simultaneously runs all the sensors, operates the satellite radio and tracking software, and manages the power system. Based on a PC/104 486/100 processor with 16MB of RAM, the data system runs the Linux operating system, so multiple tasks run simultaneously. It accommodates all standard interfaces so that virtually any desired sensor can be quickly added.

The standard buoy configuration collects a comprehensive set of atmospheric and oceanographic data. Atmospheric data products include wind speed and direction, atmospheric temperature and pressure, measurements of photosynthetically active radiation and compass orientation of the buoy. Oceanographic data products include current direction and velocity (ADCP), temperature and salinity, pressure, and a variety of bio-optical measurements. GPS contributes location information, time stamps data, and keeps the system clock accurate enough to track satellites.

The sampling rate of each sensor can be independently set, and the WavSat command capability allows sampling rates to be remotely adjusted at will. Although telemetry throughput limits the amount of data that can be returned through that channel, it does not limit the data that can be stored onboard the buoy for later retrieval. Typically, data streams with one-second sample rates will be kept. These streams are then subsampled or averaged at one- to five-minute intervals for transmission to the Wavix Data Center. Thus, extremely dense data sets are possible.

The WavSat system's robust design, combined with the configuration flexibility of the mooring and its data system, make the Wavix system an excellent solution for large operational programs, industrial or scientific.

The Future

An increasing awareness and concern over the human impact on climate change, plus recent changes in the oil industry, have created a significant demand for much larger quantities of data from remote ocean regions. Cost-effective, high-throughput satellite communications for remote data platforms will become increasingly important over time.

The ability to retrieve large amounts of data in real-enough time, coupled with an interactive data platform, will change the way remote oceanographic data collection is done, and enhance the utility of ocean-observing systems for industry. Until now, research programs have been constrained by the limits of one-way, low-volume data returns. Eliminating the data-transmission barrier will lead to a revolution in operational oceanography, allowing more dense data returns in real-enough time such that scientists can look at ocean processes in unprecedented detail.

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