Underwater Acoustic Modems

Datasonics/Benthos

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Acoustic Telemetry Technology

Modems were developed to allow computers to exchange information over a network of telephone lines. To process information, a computer reduces data to a digital format of 1's and 0's, representing the two values by either the presence or absence of an electronic signal. The modem, which is short for modulation/demodulation, converts this digital representation to sounds which, in turn, are coded by the telephone lines as electrical signals. In this modulated or analog format, the digital 1's and 0's are represented by different frequencies within a defined bandwidth. At the receiving end of the transmission, another modem converts the signal from frequency form back to digital form so that the data can be accepted and processed by the receiving computer.

The Challenges of Underwater Acoustic Telemetry

Baud Rate

The key performance parameter for a modem is its data transfer rate, which is usually measured by baud rate, or the number of bits per second the modem can reliably generate and receive. Baud rates of 28,800 and 56,600 are now commonplace in PC communications.
On land, the medium between modems is the benign environment of a shielded wire or the sharply defined path of a microwave transmission. In these environments, it is relatively easy to achieve fast and reliable transmission of large amounts of data. Without much competition, the discrete signals can be sent out in very close proximity and still be properly understood at the receiving end. And, as signals begin to fade over distance, network facilities recondition the signals so that they arrive in a clear, unambiguous form.

Underwater Acoustics

Unfortunately, in many underwater applications, a wire connection with submerged instrumentation is either prohibitively expensive or not feasible. The solution is to use the water itself as the medium for the transmission of acoustic signals. However, this solution presents several problems. First, sound travels through water at a much slower speed, approximately 1,500 meters per second, compared to electrical transmissions on a phone line, which travel at the speed of light.

Multipath Echoes

Secondly, the water is an open channel into which the acoustic signal is broadcast. Even when the transmission is a narrow beam aimed at its target, the sound wave fans out and generates echoes which arrive at the target destination shortly after the original signal. These multipath echoes require additional processing as the signal is received.

Need for Overhead

The open-channel broadcast also results in the need for more processing with each transmission to assure that the target, and only the target, receives the message. Finally, water can be a much more hostile environment. The signal is affected by changes in water temperature, turbulence, objects in the water and a host of other factors.

New Advancements Found in the Telesonar System

Improved Data Reliability

The Benthos Telesonar System employs two high performance modulation schemes which effectively reduce the physical barriers to underwater communication, these include 1 of 4 MFSK and Hadamard MFSK.

- 1 of 4 MFSK: An advanced modulation scheme which allows for high speed (up to 2400 baud) data transmission. 1 of 4 MFSK is bandwidth efficient, fast and relatively simple to encode.
- Hadamard MFSK: An advanced modulation scheme used to minimize the effects of frequency dependent fading. This scheme also allows the system to operate at a lower signal to noise ratio (SNR) by working reliably at lower transmit power levels. (Data rates drop to a maximum of 1200 bps when utilizing Hadamard.)

In addition to 1 of 4 MFSK and Hadamard MFSK, Datasonics Telesonar System incorporates three other methods for increased data reliability. These include data redundancy, convolutional coding and multipath guard period. All three methods are user selectable and can be applied when using either of the above modulation schemes. When utilized, the data rate will remain 2400 bps, however, the effective baud rate (through put) will be reduced to allow for data coding, which results in increased reliability.

- Data Redundancy: Data redundance, also referred to as frequency diversity, is a method whereby the same data bits are transmitted two or more times in the same data frame. Therefore, reliability is increased by transmitting the same data bits twice in a single data frame.
- Convolutional Coding: An error correction technique in which a Viterbi algorithm is implemented to detect and correct errors.
- Multipath Guard Period: An effective technique for use in high multipath environments. This feature allows the user to incorporate a selectable delay period between data frames. This brief delay allows time for the multipath to die down in the communication channel before sending out the next data frame.

System Versatility

The Benthos Telesonar system has been designed to provide optimum system versatility. Examples of this versatility include modular packaging designs, and the availability of modules for OEM integration. Other new configurations include:

- Customer Selectable Frequency Range: The Telesonar System can be configured to operate within the 1 to 40 kHz range. Standard frequencies include low band (9 - 14 kHz), mid band (15 - 20 kHz) and high band (25 - 30 kHz).
- Customer Selectable Transducer Arrays: Each of Datasonics Telesonar Acoustic Modems can be configured to include a directional, omnidirectional, or line array transducer.
- Remote/Integral Transducer Configuration: Each of the Telesonar Subsea instruments can be configured to include either an integral or remote transducer configuration, depending upon space and orientation requirements.