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The SID-100 Seismic Intrusion Detector is a low cost sensor/processor/transmitter designed for compatibility with most field receivers (shown with a standard ICOM transceiver). *Page 2*

The Eagle Intrusion Detection System (EDIS) is an intelligent, discriminating remote sensor system. Designed for low power long-term deployment, it features seismic, magnetic and passive infrared sensors with a repeater option. *Page 4*

The TS-200 and the 300 series of miniature narrow band FM audio/data transmitters remain operational for nearly 4.5 hours under continuous transmit conditions. Longer operating times are possible using an external battery or DC power supply. *Page 6*

Special Issue

Wildlife technologies are being adapted for use in other fields.

For the past 25 years, Telonics has been involved in the development and production of radio telemetry systems for application to wildlife. Adapting aerospace and communications technology for use in recovering position and data from free ranging animals has been and continues to be the principal focus of our research and development programs.

Over the years and with increasing frequency, scientists in other disciplines have recognized that VHF and satellite telemetry produced initially for tracking and recovering data from wildlife could also prove valuable in recovering oceanography, climatology and geological information. As a result of this need, we have often adapted “wildlife” technologies for use in non-wildlife applications throughout the environmental fields of study.

This technological cross-fertilization has always occurred as tools specifically designed for one application are discovered by individuals working in other disciplines under similar constraints with related technological needs. As I am sure most everyone can imagine, there are numerous non-scientific applications which can make good use of low power, microminiaturized equipment designed for long term deployment in extremely harsh environments.

One particularly suitable application is law enforcement. On numerous occasions in the past, we have been contacted by various organizations such as police departments, wildlife law enforcement groups, the border patrol and various other agencies. While it’s not always possible to directly apply wildlife technology to other applications, we have kept the particular requirements of the law enforcement community in mind when designing new equipment. Upon occasion, we have developed specific equipment to meet their special needs in urban as well as rural and wilderness environments.

This issue of the Quarterly is a departure from topics we have discussed in previous newsletters in that it specifically addresses law enforcement applications and the specialized systems we have developed for various agencies.

While we have been producing law enforcement tools for many years, we have not previously displayed the equipment nor have we published information concerning new developments. Word-of-mouth, however, has created a demand for our equipment in a variety of law enforcement applications. Now that the word is out, the time has come to make more information available. As the world of the law enforcement officer becomes more dangerous, the security of the operation or individual can depend on reliable tools. We feel a certain obligation to provide those tools whenever we can.

Another benefit to publicizing information about new technologies is to facilitate a reverse flow of information. Specifically, technologies developed for law enforcement can find uses in the wildlife field. In point of fact, this has already happened. The TS-200 audio transmission system, designed for law enforcement as a body microphone, has already been utilized to monitor the audio environment during the capture of seals in the Arctic. By utilizing this technology, the sound of the captured seal is immediately transmitted to a base station where the information triggers the recovery of the trapped animal.

These two applications – wildlife and law enforcement – are so closely aligned that cross fertilization in the future is virtually assured. As members of the law enforcement community read through this issue, they may be startled at the progress that has been made and, as wildlife research professionals read the same material, ideas may come to mind for adapting these technologies back to the wildlife research field. In fact, the line between the two is quite fuzzy because the basic requirements for both are very similar.

OK, so you knew we must have been doing this work all along and just not telling anybody. Well, you were right!

Stan Tomkiewicz

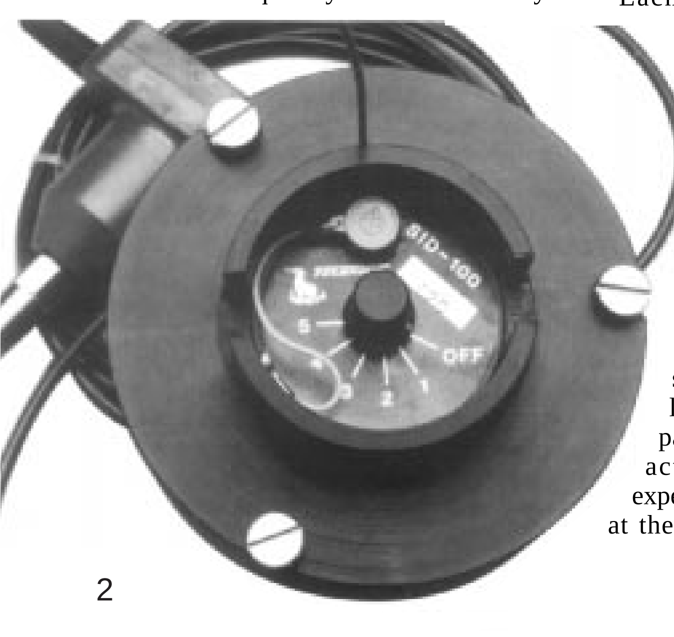
SID-100 Seismic Intrusion Detector

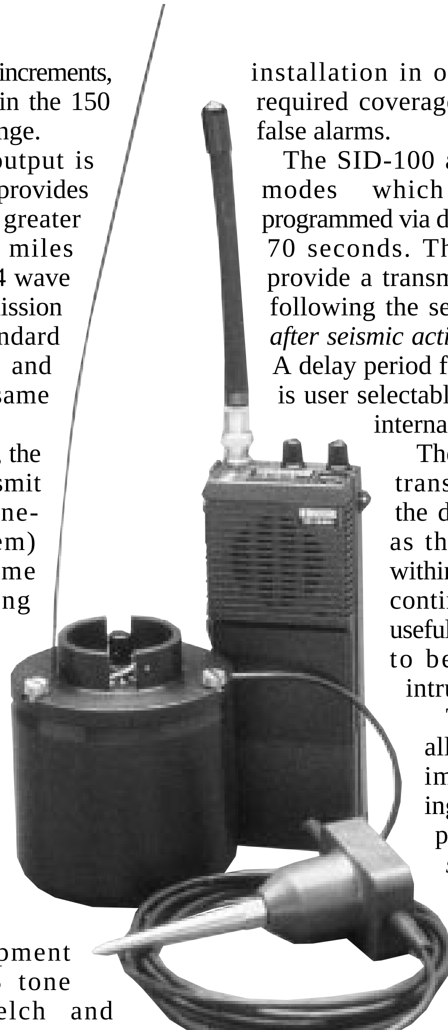
Designed for compatibility with most field receivers.

The SID-100 is a compact, self contained, single-point seismic activity sensor/processor/transmitter which provides near-realtime notification of seismic activity within an area of deployment. It was developed as an inexpensive means of monitoring and reporting activity, and may be used for law enforcement as well as wildlife applications. The unit deploys rapidly and is designed to be compatible with most FM receivers already in use.

The processing circuitry, transmitter and battery pack for the SID-100 are contained in an O-ring sealed weather tight container which is designed for long-term burial in outdoor environments. The compact size (approx. 4 in. dia. x 5 in. high, 10 x 13 cm) and rugged construction make it ideal for use in tactical situations. It may be deployed near a trail or road to provide notification of approaching activity or used as a lookout for the perimeter of your camp.

The SID-100 incorporates a speech synthesizer which transmits an audio message. The unit's ID number (1 through 8) is received as a male voice message on a standard walkie talkie or receiver. The ID number is user selectable via a dip switch located within the unit. When used to monitor a trail, several units may be deployed with the ID numbers sequenced. As the subject advances and each succeeding sensor is activated, the listener hears "THREE," "TWO," "ONE," and so forth. The message is transmitted on a VHF narrow band FM frequency which is factory programmed in 12.5 KHz increments, selected by the user within the 150 to 175 MHz frequency range.





The transmitter RF output is 200mw which typically provides an operational range of greater than 1/4 mile (several miles "line of sight") with a 1/4 wave whip antenna. The transmission may be received by standard handheld walkie talkies and receivers tuned to the same frequency.

To simplify monitoring, the SID-100 may also transmit CTCSS (continuous tone-coded squelch system) subaudible tones. Some of the systems utilizing it are General Electric "Channel Guard", Motorola "Private Line" and E.F. Johnson "Call Guard." In these systems, transmissions are sent with a CTCSS tone modulated at a frequency that is inaudible to the human ear (below 250 Hz).

The receiving equipment looks for the CTCSS tone before opening squelch and accepting a transmission. These discriminating systems receive only communications which are encoded with the CTCSS tone, thereby eliminating the interference of stray communications. It is important to note that CTCSS is not an encrypting method and the transmissions may be received by others operating with standard non-CTCSS equipped receiving equipment. The CTCSS tone frequency is user selectable in the SID-100 by internal soldered jumpers for all 37 standard CTCSS frequencies.

Each deployment is unique and therefore the sensitivity of the seismic sensor (which detects vibration in the ground) is user selectable in the field via an external 6 position switch to best suit the application. Soil conditions vary greatly and require different gain settings to optimally detect seismic activity.

The unit typically requires a higher gain setting (increased sensitivity) when deployed in loose sand as compared to hard pack clay which transfers seismic activity extremely well. Some experimentation is necessary to arrive at the optimum gain setting for each installation in order to obtain the required coverage without incurring false alarms.

The SID-100 also offers 2 delay modes which are internally programmed via dip switches from 0 to 70 seconds. The first mode will provide a transmission *immediately* following the selected delay period *after seismic activity is first detected.* A delay period from 0 to 70 seconds is user selectable in the field via an internal dip switch.

The unit will continue transmitting following the delay period as long as the seismic activity within the monitored area continues. This mode is useful when it is important to be notified of the intrusion immediately.

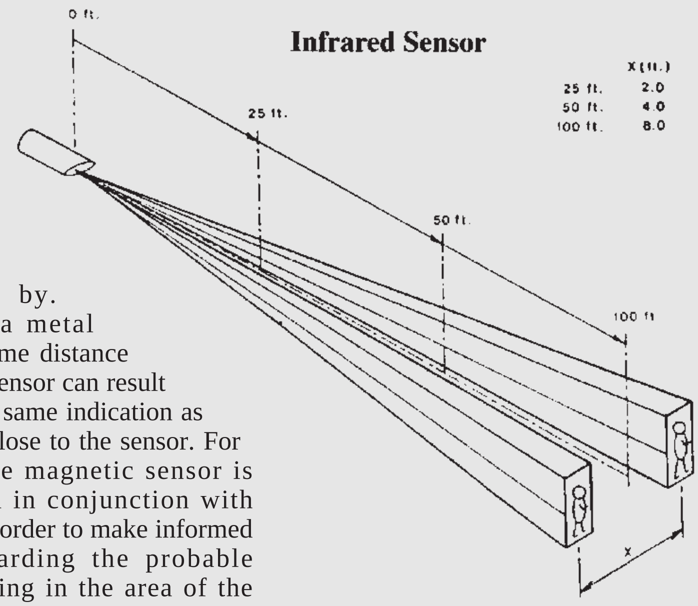
The second mode allows a transmission immediately following the selected delay period *after the seismic activity in the monitored area ceases.* Use of this delay mode may assure security of the unit if the intruder is capable of detecting the transmission while passing through the monitored area. This mode may also be used to alert the user when the monitored area is clear (such as when a bear leaves the area of his den).

The SID-100 is powered by two 9 volt alkaline cells (Duracell MN1604) which are available at most stores. The lid of the case may be opened to allow easy battery replacement.

The unit also provides a switch closure output that may be used with an electronic shutter camera. The camera is triggered immediately prior to transmission. This feature may be used by researchers to obtain a picture during studies which monitor activity at an animal's den or to monitor a trail and record who or what is using it.

During a tactical operation, the SID-100 Seismic Intrusion Detector provides a low cost approach to monitoring a fixed site or trail. The effectiveness of the unit may be expanded by the ingenuity of the user and put to work in many applications. If deployed properly, the SID-100 can provide notification of seismic activity resulting from an intrusion occurring within the area of sensor deployment. *Scott Jarvis*

SENSORS



Telonics provides three different types of sensors for law enforcement applications. The SP-500 Seismic Sensor is used in the low cost SID-100 and the sophisticated Eagle Intrusion Detection System (EIDS). Two other sensors, the MG-510 Magnetic Sensor and IF-520 Passive Infrared, are also supported by EIDS.

Seismic

The SP-500 Seismic Sensor incorporates a precision wound wire coil suspended around a magnet by very small springs. The magnet is securely mounted to the outer case of the sensor. The coil is unable to move instantaneously due to its mass and supporting structure. Therefore, when the ground in which the sensor is buried moves, the sensor's case and magnet move with the earth while the coil tends to remain stationary (in the short term).

As the magnet's lines of force move through the coil, the movement generates current flow in the windings of the coil (in exactly the same manner as any electrical generator). The voltage that is thus generated is proportional to the relative velocity between magnet and coil.

Seismic sensors are designed to detect any movement of the earth within range of the sensor and are therefore incapable of distinguishing between various types of movement by themselves. Further processing of the generated signal must be performed to help identify a specific activity.

Magnetic

The MG-510 Magnetic Point Sensor is a small unit which can be buried alongside the roadway, path or other area to be monitored. It consists of a highly specialized electronic circuit which senses perturbations in the earth's magnetic field. It is only sensitive to *moving* ferrous objects within its sensing field range and is not affected by nearby stationary metal (signs, "rebar" in concrete, door frames, etc.).

Sensitivity is dependent upon the size and distance of the metal object which passes by. Accordingly, a metal tank passing some distance away from the sensor can result in relatively the same indication as a rifle passing close to the sensor. For this reason, the magnetic sensor is generally used in conjunction with other sensors in order to make informed decisions regarding the probable activity occurring in the area of the sensor. (For example, it is helpful to know if the object tripping a seismic sensor near a roadway is metallic in order to differentiate between an animal and a vehicle. If the object is not metallic, other methods are available within the PT-100 Processor/ Transmitter to discriminate between animals and people, etc.).

In some applications, two magnetic sensors may be employed to determine the direction of travel for a metallic object such as a car or bicycle. Magnetic sensors are relatively short range devices; they can typically detect cars at up to 60 feet, motorcycles at 25 feet, bicycles at 20 feet, etc.

Passive Infrared

The IF-520 Passive Infrared Sensor detects changes in infrared energy that occur within the sensor's field of view. These changes are detected by a pyroelectric detector which collects the optical power (infrared energy) "seen" through its optics and converts it to an electrical output (current). The detector consists of a special window, optical elements, sensing element and integral electronics. The window restricts the incoming infrared radiation (thermal energy) to a wavelength of interest. The sensing element responds to changes in thermal energy and produces an electrical signal. The electronics interfaces the electrical signal to the PT-100 Processor/Transmitter for further processing prior to transmission of a "sensor trip" indication signal.

Every object emits or reflects infrared energy as a function of its size, composition, color, etc. *The detectability of an object is influenced by the thermal contrast of the object to its background* (signal-to-noise ratio). Hence, a lightly clothed person against a "cool" background at night is more easily detected than a fully clothed person against a warm background in the heat of day. Our sensors detect temperature contrast as little as 1.0° C.

While the maximum detection range of the IF-520 is approximately 150 feet, the IF-540 is a long range passive infrared sensor with a range of 400 feet. Both sensors incorporate two independent detectors and their associated electronic circuits in one package. The use of two detectors with common optics allows the target's direction of travel to be determined (left-to-right or right-to-left). The field of view is shown above.

The sensors possess no direct intelligence of their own. Their output signals must be further processed to derive the lowest level of decision making. By deploying different types of sensors with a PT-100, the data received can usually provide sufficient information to classify an activity occurring in the monitored area.

Eagle Intrusion Detection System

A low power system for long term deployment.

In 1988, Telonics entered into a Joint Venture arrangement with a Texas company, Eagle Security Enterprises. The purpose was to respond to a growing need for a reliable remote sensor system by the U.S. Border Patrol. The technical team which formed was to examine existing sensor systems and then design a new system which would eliminate known weaknesses and take advantage of modern low power technology to establish a new generation remote sensor system. One important constraint placed on the new equipment was that it be compatible with the existing Border Patrol system to ease the process of transition from old to new.

What followed was a project which encompassed three years of research and development, resulting in a highly flexible system not only compatible with the existing Border Patrol system, but capable of being adapted to a range of other widely varying government and commercial applications. The system that evolved is known as the Eagle Intrusion Detection System (EIDS).

The EIDS system is composed of the following components:

- Seismic (SP-500), Magnetic (MG-510 and Infrared (IF-520/lF-540) sensors to detect activity
- Processor/Transmitter (PT-100) to filter and process sensor output and to transmit messages
- Repeater (RP-301) to extend the range of the system
- Receiver (RM-201) to decode the message and display it for the user.

The operating temperature range of each EIDS component varies, but all are designed to work reliably in the temperature extremes on both the northern and southern U.S. borders.

SENSORS: Any or all of the following sensors may be used with the PT-100, but are purchased separately. For a more technical description of how these sensors operate, refer to the sensor sidebar on Page 3.

The *SP-500 Seismic Probe* uses a geophone, which detects very small movements in the ground. The probe is configured with the sensor on the end of a metal spike which is pressed into the ground, thereby coupling the sensor to the ground. This sensor is used to detect people walking and/or moving vehicles. Through the use of specialized filters incorporated into the system and with proper installation, EIDS is able to successfully differentiate between vehicles and pedestrians.

The range over which this sensor is effective varies with the type of soil in which it is deployed. Softer soil compositions tend to absorb motion through compaction, while more rigid soils transfer motion more efficiently. For example, in hard-packed clay the maximum range of detection for a person walking is typically 100 to 200 feet, while in loose sand the maximum range might be 15 to 35 feet. If large areas need monitoring, the geophones may be deployed in a “string” configuration where a single cable of 10 geophones is spaced 100 feet apart allowing the user to effectively cover 1000 feet.

The *MG-510 Magnetic Probe* is a very sensitive magnetic flux detector used to detect disturbances in the earth’s magnetic field which occur when ferrous metal passes by the sensor. The range is dependent on the size of ferrous metal in the object disturbing the field and the speed with which it moves through the field. Vehicles are generally detectable up to 60 feet while detection of bicycles occurs up to 20 feet.

The *IF-520 Passive Infrared Probe* is an infrared detector telescope used to detect a temperature change within its field of view. It is very sensitive and can detect changes as small as 1° C.

Two directional IR probes, the IF-520 and IF-540, are available. The IF-520 has a range of up to 150 feet and the IF-540 a range of up to 400 feet. The detection range is based on a human subject walking through the field of view. The output from these sensors is provided to the brains of the EIDS system, the PT100 Processor\ Transmitter.

PROCESSOR/ TRANSMITTER: The PT-100 is configured to accept one Seismic input and two additional inputs which may be used to accommodate either Magnetic, PIR (Passive Infrared) or a combination of Magnetic and PIR.

The signals received from the sensors are amplified and then filtered to provide a clean signal to the internal processing circuitry. Following detection and qualification of the sensor input, a message is formatted and transmitted. The message includes a unique transmitter ID number and a sensor number which identifies the particular sensor which was triggered. At the time a detection occurs, the PT-100 can also provide a trigger to control the electronic shutter of an external camera to record the event on film.

The PT-100 is unique in that it combines a transmitter with the processing circuitry for three sensor inputs in a single package. This single compact unit minimizes the amount of equipment that must be carried in the field, as well as the size of hole that must be dug to bury it. The processing circuitry and transmitter are controlled by an extremely low power microprocessor. Through the use of the microprocessor, both functional capabilities and operational life have been greatly expanded over units utilizing older technology. The PT-100 will operate for 12 months with two alkaline lantern batteries (Duracell MN-918, based on transmitting one message every 6 minutes). The microprocessor allows the user to customize the configuration of the PT-100 for the particular deployment being undertaken through the use of a portable handheld programmer (PG-400) in the field or via a computer in the lab.

A few of the programming options available to users are as follows:

- The sensitivity level may be programmed to adjust the range of detection for each independent sensor.
- The footsteps counted to classify a target as a pedestrian when using the SP-500 is adjustable from one to 15.
- Unique channel numbers may bc programmed for each sensor. This number is transmitted as part of the message, allowing the user to determine which sensor was triggered.
- The Magnetic and Passive Infrared sensor channels may be configured as stand-alone sensors, or they may operate together to determine the direction of travel.
- If the optional tamper circuits are installed, an alarm may be turned ON or OFF to alert the user if tampering occurs with the Infrared sensor.
- A status message telling the user that the unit is “alive and well” may be programmed to occur at a user selectable time once per day.
- The PT-100 may be programmed to operate continuously or only on specific

days of the week during specific hours of the day.

- The unique identification (ID) number that is transmitted is adjustable from 0 to 8191.
- Transmit frequency is adjustable in 12.5 KHz steps over the user selectable frequency band for which the PT-100 is configured.
- The output power of transmission is adjustable for either 1.5 or 5 watts.

The PT-100 is designed to interface with existing U.S. Border Patrol equipment and, as such, can be programmed to transmit a digital message in the standard Border Patrol format. The PT-100-V is a modified version in which the digital message is replaced with an artificial voice message. This allows use of a narrow band FM receiver (walkie talkie) tuned to the same frequency to receive the message. The message received is a male voice reciting the ID number and the specific sensor number that has been triggered.

An additional feature incorporated with the voice messaging is the ability to combine a CTCSS sub-audible tone with the transmission. This allows the PT-100V to be used with radios that utilize CTCSS sub-audible tones.

All parameters of the PT-100 are user-adjustable with the use of a PG-400 handheld programmer or an IBM compatible computer with a standard RS-232C serial port (using software provided by Telonics). The PG-400 is a small, portable, battery-powered programmer connecting to the PT-100 via a cable and allows the user to customize the PT-100 for each particular installation. The compact size, backlit keypad and display make the PG-400 ideal to program or modify PT- 100 parameters in the field.

REPEATER: The RP-301 Repeater provides the necessary intermediate VHF/VHF receiving link for transferring messages over long distances or from remote, rough terrain where line-of-sight deployment from the PT-100 to the RM-201 Receiver is not possible.

The RP-301 is a fully programmable, portable, battery-powered, simplex digital repeater. It may be factory configured to work with either the digital or voice versions of the PT-100 Processor\Transmitter. Similar to the PT-100, the RP-301 can be configured in the field via the PG-400 handheld programmer or IBM compatible computer for the particular installation being undertaken. Some other features which are directly programmable in the RP-301 include:

- Selectable RF output (1.5 or 5 watts)
- ON/OFF trigger for an external camera
- Selectable receive frequency
- Selectable transmit frequency

The RP-301 allows the user to program receive and transmit frequencies independently with as much as 8 MHz spacing between them.

For use with non-Border Patrol applications, the RP-301 can be programmed to append its own unique ID number to the end of the relayed message. This allows the user to know which repeater the message was processed through when multiple repeaters are deployed.

RECEIVER: The final link in the EIDS system is the RM-201, a specialized portable battery powered narrow band FM digital receiver. Messages are processed and displayed on a two line by 16 character display. The information includes the time and date the message is received, the transmitter ID number and sensor number of the unit triggered. In addition, the receiver formats and outputs the received message over an RS-232 link to any attached data logging device.

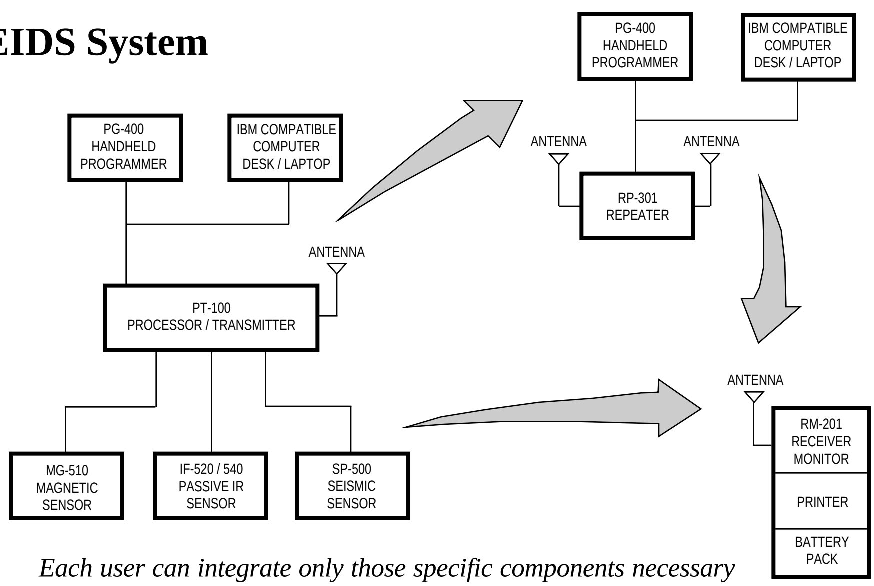
Included with the RM-201 carrying case is a small dot matrix printer and battery pack which provide the user with a hard copy printout of the messages received. For laboratory or base station use, the RM-201 may be connected to a computer via a serial port, and the received messages further processed or directly stored in a data file. On-board memory is provided which retains the last 250 messages received in chronological order and allows the user to scroll through them as long as the receiver is ON.

The receive channel may be selected from one of 10 different frequencies via a digi-switch located on the top panel. These 10 channels are factory programmed with frequencies supplied by the customer.

Further work is ongoing to enhance classification of the detected seismic signals to minimize falsing caused by animals (deer, cows, etc.). Also being studied is integration of the EIDS system with a video link. This will allow for transmission of a picture over the narrow band FM link when a detection occurs. As these projects come closer to fruition, they will be reported on in greater detail.

The development of the EIDS system has resulted in a very capable system for the detection and reporting of intrusions. The equipment is currently in production and being used with great success in the field. EIDS provides the user with the means to monitor remote sites. Due to the flexibility designed into the system, it can be adapted for use in a wide variety of operational scenarios. *Jim Carter*

EIDS System



Each user can integrate only those specific components necessary to customize the system for a particular application. Individual components may be purchased independently.

What Did They Say?

A pair of high performance audio transmitters.

For sometime Telonics has been developing a miniature battery powered audio/data transmitter. The initial design effort was driven by the scientific community's need for a system to study the audible environment surrounding animals. As the program unfolded, law enforcement groups expressed a similar need in the fight against poaching, rustling, hijacking, and drug dealing.

Although the two applications seem vastly different, the hardware design requirements are remarkably similar. In fact, there is a great deal of similarity between a surveillance system remotely located to catch poachers, dopers and hijacker, and a system to track and monitor animals in their natural habitat. Because of this similarity, Telonics was able to combine the requirements into a single transmitter development effort.

The TS-200 and 300 series of miniature narrow band FM transmitters have been designed to include many features normally found in very expensive, sophisticated commercial systems. They are suitable for applications where ruggedness, frequency agility, low power, small size and low distortion audio processing are required. While the units are primarily intended for voice or tone operation, they incorporate circuitry which allows their use in low data rate (200-9600 bits/sec) digital data applications with minor modification.

Most existing "cheap" FM transmitters are supplied in an open printed wiring board construction completely devoid of packaging. The manufacturers leave the packaging details (and ensuing problems) to the user. At Telonics, we consider the mechanical packaging crucial to the successful application of all our designs. In fact, the sturdy metal case surrounding the electronic circuitry of the TS transmitters provides several important functions. It protects the circuits from normal abuse during operation, provides thermal heat sinking for critical components at high temperatures, and isolates sensitive circuit elements to ensure stable performance.

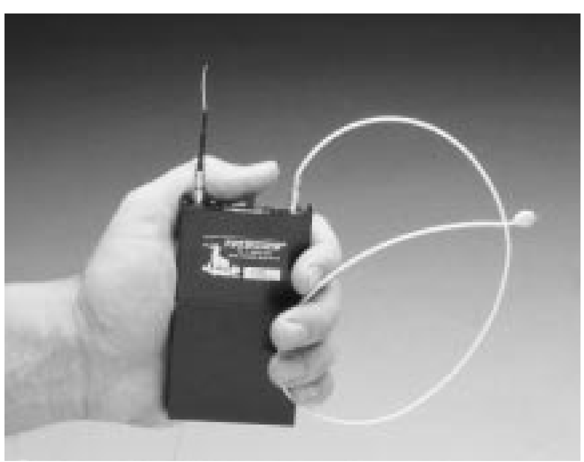
The mechanical design must also provide a user friendly interface between the operator and transmitter controls. For example, in the TS transmitters, the interface functions include slide switches for frequency selection, a soldered-in coax connector for antenna attachment, a miniature plug for remote control operation, and a specially designed battery compartment to accommodate a 9VDC battery. A slide-on metal cover allows easy access and protects the battery during normal operation. The internal battery is a 5K69 alkaline cell initially designed for camera applications and is readily available at most retail appliance stores.

The TS-200 and 300 measure 2.2 x 1.7 x 0.45 in. (5.6 x 4.3 x 1.1 cm) excluding connectors, switches and protrusions.

An important design requirement often overlooked until too late is transmitter performance over temperature. When a manufacturer avoids specifying the temperature performance, it usually indicates either poor performance or a conscious decision by the manufacturer to minimize operating costs. In either case, the buyer should beware.

The "cheaper" systems often employ active and passive components with performance unspecified or uncontrolled at low voltages, high frequencies and temperature extremes. These systems (if they work at all) are usually inefficient, consume higher current, and require larger battery capacities to maintain a suitable transmitter power output.

For a given battery system, the higher current drain implies reduced battery life. As most of you are aware, getting the longest life from a specific battery type has always been a fundamental design concern at Telonics. This expertise, in conjunction with exiting component quality control, is inherent in the design of the TS-200 and 300 transmitters. Experience shows that keeping power amplifier efficiencies high, choosing quality components, and reducing thermal losses by proper packaging techniques will maximize performance at temperature and voltage extremes.



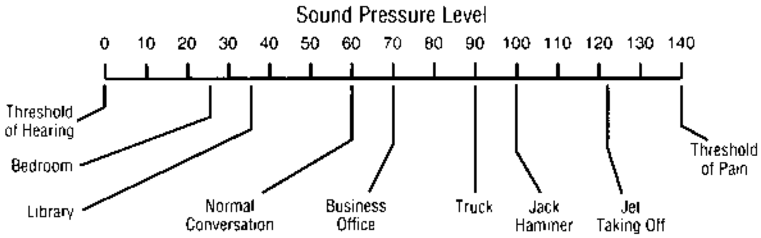
In the TS-200 and 300 transmitters, these approaches maximize the operation time to nearly 4.5 hours under continuous transmit conditions. Longer operating times are possible using an external battery or DC power supply. External power is applied through a 4-pin connector located on the case. This feature is most commonly used when the transmitter is to be remotely controlled from a separate "switch" receiver.

Both transmitters contain a high quality internal electret microphone whose frequency response is specifically shaped to match the 300 to 3500 Hz characteristics of normal voice. Remote microphone operation is provided via a 4-pin microminiature connector located on the front of the case and operation is possible up to distances of 30 feet.

A complaint often associated with existing transmitter designs is their inability to provide a simple and reliable means of changing the operating frequency. Although manufacturers of single channel, crystal-controlled transmitters claim that frequency change is accomplished by simply replacing the crystal, experience shows that successful substitution is dependent on the specific oscillator circuit and thoroughness of the initial design. Unless the user is familiar with the sensitivity of the crystal parameters, proper performance with the replacement crystal is questionable.

In the TS-200 and 300, we have removed this uncertainty by employing digital frequency synthesis to implement changes in operating frequency. Recent developments in technology and micropackaging have made this approach possible. In our transmitter design, one internal precision crystal is used in a phase-locked loop circuit to synthesize up to 2400 separate channels in the frequency band of 100 to 200 MHz. Although the transmitter is fully synthesized over an octave of bandwidth (100 to 200 MHz), broadbanding the power amplifier for the total range reduces efficiency and increases harmonics and battery drain.

Therefore transmitter band selection is left as a user specified parameter which can be optimized for a particular application. The maximum usable bandwidth without retuning is typically 12 MHz. Rf channel selection is performed internal to the transmitter via wire jumpers or microminiature dip switches. A front panel option is available which allows any two channels to be selected from a slide switch located on top of the case.



One of the most challenging design goals was to develop an audio processing scheme which would best fit the vastly different acoustical scenarios of the law enforcement and scientific communities. For example, audio processing schemes for the scientific user may require processing signals from a relatively quiet location such as a remote forest. The same processor for law enforcement use often processes signals from very loud locations such as city streets, restaurants, and nightclubs. We quantify these different intensities into sound pressure levels (SPL) with respect to some acoustic reference (usually the threshold of hearing). Before a processing scheme can be chosen, the range of input levels impinging on the processor must be identified. While the best way to identify this range is to measure it, most of the time this is impractical or difficult to do. Fortunately, the relationship between sound pressure level and a variety of well known scenarios has been well documented. From these, the designer can overlay his own scenarios and select the corresponding range of sound pressure levels.

It can be seen from the above chart that the sound pressure levels corresponding to the wildlife and law enforcement extremes fall in the range 20 to 110 dB SPL, and represent a sound pressure change of 90 dB. This means that the audio processor must accommodate input level variation of nearly 30,000:1. To achieve performance at both SPL extremes, the audio system must linearly process these levels without inducing noise or creating distortion.

One way to accomplish this performance is to use some form of limiter or automatic gain control technique. Most cheaper transmitters are incapable of processing both extremes simultaneously. The designer sacrifices performance at both extremes to preserve linear performance in the middle. Most of these systems employ some form of limiting or crude automatic gain control.

In a limiter, when the average audio level remains above the limiting threshold, severe clipping occurs creating high distortion and rendering the transmitted audio nearly unusable. Limiters are not all bad, however. If the input level is relatively constant and the limiting threshold can be set so only strong peaks are limited, then a properly designed audio limiter can function in an effective manner. In fact, the TS-200 employs a limiter of this type that has proven more than adequate in several field applications. However, when the range of input levels is extremely large, the limiter breaks down and noise or distortion dominate. Consequently, in wide dynamic range situations, the limiter is considered inadequate and some form of AGC is usually employed.

When such audio AGC techniques are required, they generally consist of an audio amplifier, detector, some form of filtering and gain control attenuator. The amplifier provides the gain necessary to modulate the transmitter. The detector and associated filtering create a control voltage which is used to set the value of the attenuator. Since the attenuator and amplifier are in series with one another, the combined gain is modified by the AGC action to keep the output constant. Because such systems have the control function in opposition to the input change, they are referred to as negative feedback control systems.

As simple as this approach may seem, it requires considerable knowledge regarding the dynamics of speech to select proper feedback characteristics. For example, in speech the syllabic rate (rate at which syllables are formed) is typically 8 Hz/sec. If the AGC is to adjust its gain to the average change of these syllables, then the feedback response must be slow. On the other hand, the transient nature of speech peaks are fast with peak-to-average amplitude variations as large as 100:1. To prevent these peaks from driving the amplifiers into limiting requires an AGC feedback response which can react very quickly. Thus designing an AGC circuit with a single feedback loop to perform both fast and slow requirements forces the designer to trade off attack and release performance (fast and slow response) against other requirements such as loop stability, distortion and dynamic range.

We have developed another approach which minimizes these tradeoffs and improves signal quality, and have incorporated it into the TS-300 transmitter. This unique design uses two loops, one to perform the slow averaging function and the other to respond rapidly to sudden changes in input level. The combined output is then applied to the voltage controlled attenuator and amplifier to maintain a constant output. In this approach, the fast loop engages only when transient conditions prevail or speech peaks approach limiting. Therefore the dual loop technique, with the fast loop to prevent overload, allows the slow loop threshold to be reduced improving weak signal performance in quieter locations. Using the dual loop approach, distortion products in the TS-300 are held below three percent over an input level range of 80 dB (10,000:1).

Although the dual loop technique allows lower threshold performance, it can only be achieved if the internal noise of the AGC itself is below that of the operational environment. In other words, all of the improvements gained by using a dual loop approach may be lost if the internal noise exceeds the minimum input signal. Therefore, our input semiconductors and associated circuitry have been specially selected to minimize internally generated noise.

Both transmitters include a 6 dB/octave pre-emphasis network for compatibility with existing high quality receivers. Transmitter pre-emphasis and corresponding receiver de-emphasis are terms used by system designers. They describe special audio response shaping inserted before the transmitter modulator and after the receiver demodulator to reduce noise generated by the FM process. The pre-emphasis characteristic is typically 6 dB/octave over a frequency range of 300 to 3500 Hz.

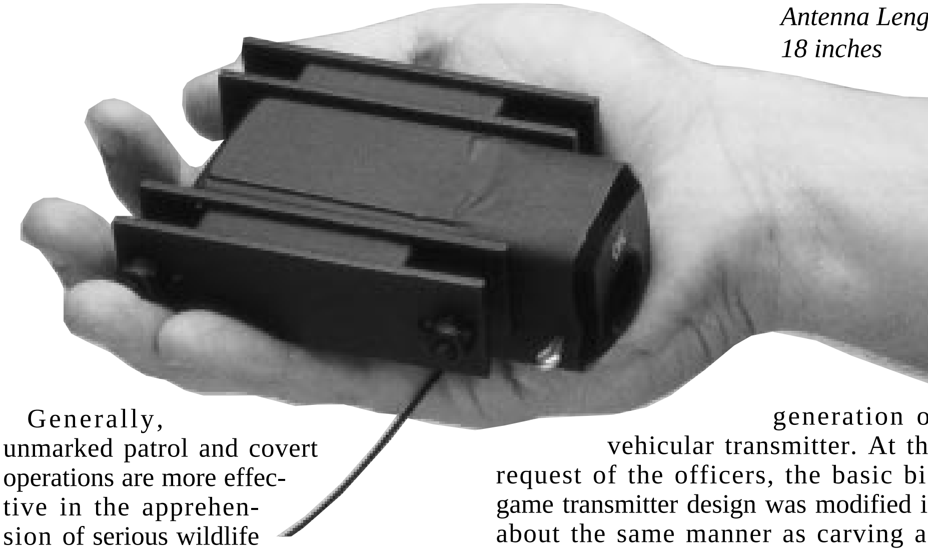
It should be evident from the preceding discussions that many performance decisions are required to design a high performance FM voice transmitter. The characteristics of TS-200 and 300 transmitters have been carefully selected to meet the goals and objectives of the law enforcement and scientific communities. The frequency range, channel synthesis, high quality audio, small size and low current consumption make them ideally suited for a number of other applications as well.

If you have a special need or would like more information regarding these transmitters, please let us know. The above discussions address only two type of users and only a handful of scenarios. There are many new and different applications yet to bc explored. From time to time, we will update you as to the progress being made in this effort.

Don Soule

Telemetry and Wildlife Law Enforcement

New technologies help protect animal resources.



MOD-400 M Antenna Length: 18 inches

Wildlife law enforcement is serious business. The investigation of the killing of a big game animal is approached by a wildlife officer in much the same manner as a homicide detective approaches the murder of a human being. The two crime scenes are similar in that there is usually a body as well as forensic evidence such as foot prints, tire tracks, fingerprints, blood, hair and fiber. Bullets may be recovered from the body or scene and cartridge cases may be found.

The wildlife officer soon becomes an expert in the outdoor crime scene due to the large number of investigations he may conduct in a short period of time. Techniques have been developed to assist in the recovery of evidence and for determining its relationship to the crime. For example, metal detectors allow easier recovery of bullets and cartridge cases. Methods are also available for determining time of death for various animals based on temperature, rigor, chemical changes and muscle response to electrical stimulus. However, such investigations are inherently reactive in nature. As successful as such work has become, wildlife enforcement agencies must also concentrate on proactive enforcement techniques.

Uniformed and unmarked patrols and covert (sting) operations are proactive methods of enforcement. They generally have not made the same advances in techniques as have crime scene investigations and laboratory forensics. Much of routine patrol is now the same as it was thirty years ago – a game of sit and wait or drive and observe – hoping to be in the right place at the right time.

Techniques are needed that will more efficiently utilize officer time and, at the same time, allow targeting of specific illegal activities or suspects. Such techniques need to be highly efficient in terms of both apprehension and prosecution of violators. One example of such a technique is the use of decoy wildlife as an enforcement tool. The recent success of these decoy programs throughout the United States and Canada rests on the basic premise of putting the good guy, the bad guy and the wildlife in the same place at the same time.

Generally, unmarked patrol and covert operations are more effective in the apprehension of serious wildlife criminals than is routine, marked patrol. The surveillance of known violators can be quite productive. However, vehicle to vehicle surveillance is difficult at best, and rural vehicle surveillance is much more difficult than that done under cover of city traffic. For years wildlife officers have recognized the need for vehicular surveillance equipment that would allow non-visual trailing. Often, intelligence information provides the "who, what, when, how and why" of suspected criminal activity. Only the "where" is missing. Such equipment would allow officers to follow violator vehicles to the area of suspected activity, or to follow illegally taken wildlife back to the suspect camp or residence.

Classical tracking devices for vehicles known as "bumper beepers" have been used by various law enforcement agencies for years. Unfortunately, the radio transmitters and receivers are very expensive and manufactured with urban agencies in mind. They are generally high powered with a high duty cycle which makes them easily detectable with low cost "scanner" receivers.

Ironically, most wildlife agencies already have a different type of remote tracking equipment for research on mammals, birds and fish. The specifications required by the field scientist are very similar to those required by law enforcement personnel. It seems now, in retrospect, that it took an awfully long time for wildlife officers to make the connection between their agency's existing use of telemetry equipment for wildlife research and law enforcement's need for similar technology.

In 1988, Arizona Game and Fish Department officers began experimenting with animal transmitters mounted on vehicles using Telonics TR-2 Receivers. By 1989, a request was made of Telonics to develop a prototype for a new generation of vehicular transmitter. At the request of the officers, the basic big game transmitter design was modified in about the same manner as carving an elephant from a block of granite – by chipping away or changing everything that didn't look like an elephant. The battery size was reduced and the power output increased slightly, resulting in a battery life of about six months. The inherent very low duty cycle was maintained to prevent detection by conventional scanners. The unit was fitted with detachable magnetic mounts for quick attachment to a vehicle. The usual magnetic switch was replaced with a spring-loaded, off-on switch. The pulse interval was changed so that it could not be mistaken for a big game transmitter, and an authorized frequency was picked that was not in use at the time. A flexible, durable antenna was used. A motion detector increased the pulse rate when activated to show vehicular movement. The result of all this is now known as the MOD-400 M.

Arizona officers experimented with this unit and found that receiving ranges were comparable to big game transmitters, but that the location of placement on a vehicle was critical. Arizona aircraft were already equipped with forward-phased, twin-yagi antennas and a removable rotary belly antenna. Almost immediately, experiments gave way to the real thing and cases began to be made on poachers of various types, some of whom had been chased for years with conventional methods. Within a year, more units were ordered by Arizona and surrounding states began to see their value. Interstate cases began to be made, with officers installing equipment in one state and the suspect tracked to another state and apprehended.

By 1990, Arizona had begun to utilize internal transmitters designed to be inserted into animal carcasses left in the field or in animal parts being transported or sold by dealers in illegal wildlife (IMP-200). These transmitters have internal antennas and were developed from implants used in live animals.

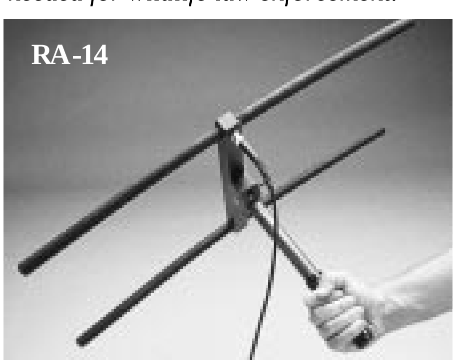
Several western states, including Utah, are gearing up for the use of these transmitters. The development of the TR-4 Receiver, with replaceable 9-volt batteries, seems made for law enforcement applications. Also, a big improvement is the recently developed heavy duty rubber ducky H antenna (i.e. the RA-14 to be released in Summer, 1992). All of us who have snapped ends off H antennas in vehicle doors can surely appreciate the "rubber ducky" antennas. They will be especially useful when tracking from horseback, helicopter and the like.

The low cost of the transmitters, and the fact that receivers are often already available to wildlife officers, make high tech surveillance a reality to the agencies charged with protecting wildlife resources from illegal harvest. Wildlife agencies contemplating the use of tracking devices for enforcement purposes should check with their prosecutors regarding the need for search warrants or other court orders, as procedures vary considerably among states and provinces.

The bottom line is that various pressures on wildlife have increased. As the effects of poaching, whether by professional poachers or opportunists, become more dramatic, the use of these kinds of enforcement techniques become more important. Whether researchers, managers or enforcement officers, we all work for the resource and can appreciate the importance of putting the serious wildlife criminal out of business.

Dave Bancroft

Editor's Note: *Dave Bancroft is currently the Area Conservation Officer for the Utah Division of Wildlife Resources. Prior to his work in Utah, Dave was with the Arizona Game and Fish Department for 22 years. The last eight were spent as a Regional Investigator stationed in Flagstaff. Dave has been working with Telonics for a number of years to develop equipment needed for wildlife law enforcement.*



Commercial Satellite Tracking

Historically, ARGOS Platform Transmitter Terminals (PTT's) have been used successfully in a variety of tracking applications. Most have been associated with scientific research in the fields of oceanography, climatology, geology and biology. Although we have not previously detailed the many roles our satellite transmitters play in other applications – tracking land vehicles, seagoing and inland waterway ships, canoes, dog sleds, and adventuresome people undertaking challenging expeditions in remote regions of the world – we hope to briefly introduce you to some of that work in this issue. While space does not permit a thorough treatise of each example, the overview which follows may provide the reader with an insight into some of the nonscientific uses of satellite tracking.

One unique application involves the tracking of fishing vessels in international waters. In 1987, the U.S. Congress enacted the "Driftnet Act" in response to mounting concerns regarding over-harvesting of fisheries by foreign vessels. In this application, our portion of the system included supplying specialized Model ST-5 ARGOS PTT's with Model CM001968 marine antennas which were designed specifically for deployment on fishing vessels. This issue of the Telonics Quarterly also includes a paper from NOAA, which provides the background and methodology associated with usage of ARGOS Data Collection and Location System (DCLS) as the means of monitoring fleets to assure compliance with international agreements. We feel strongly that this program is of special significance to the future of fisheries conservation, and we are pleased to participate.

The usefulness of tracking ships at sea is not limited to monitoring fishing fleet operations. Another application involves tracking cargo vessels carrying everything from commercial products to trash and hazardous materials. In the case of products shipped overseas, tracking information on their status and whereabouts is of commercial interest. In cases involving hazardous materials, the tracking role becomes one of environmental protection.

Another maritime application involves ARGOS tracking of yachts during transatlantic races. In this usage, the PTT helps to ensure the safety of both ships and the people on board. In addition to the transoceanic races, the U.S.S. Rattlesnake, operated by the U.S. Naval Academy, has been instrumented with a PTT for monitoring status and establishing positioning. In still other applications, PTT's have been used to track and monitor oceangoing canoes during voyages across the Pacific.

Non-marine examples are just as numerous. One scenario in which PTT's have played a role is monitoring transoceanic, manned balloon flights and long-distance flights in experimental aircraft. PTT's have also been used to relay data on the status of pipeline products – although in this role, PTT's primarily transfer information as opposed to providing position. Finally, PTT's are well suited to search and rescue work. We have made specialized units to monitor mushers trekking across the Arctic and Antarctic regions, as well as tracking mountaineers and hikers in remote regions of the world.

An early and little known application for our ARGOS PTT's involved tracking the whereabouts and status of commercial trucks, trains and ships engaged in interstate commerce. This specific program presents an interesting insight into tracking and the following background information may be useful in understanding the role of commercial satellite tracking.

With all the media hype regarding various commercial Radio Determination Satellite System (RDSS) capabilities being utilized on vehicles today, it is interesting to note that none of these commercial systems currently installed on trucks, ambulances, police, fire and delivery vehicles are actually capable of determining the location of the vehicle from a satellite. Maybe it is equally surprising to many that ARGOS DCLS and SARSAT (Search and Rescue Satellite) are the only true RDSS systems in existence today which can determine the location of an object on earth directly from satellites without aid from any other system and, further, they can provide this information to an interested party elsewhere in the world. In contrast, many current and proposed systems utilize an additional on-board receiver for LORAN, OMEGA, GPS or some other existing system to determine position. In fact, many of the systems proposed in recent years do not contain an RDSS capability and utilize the satellite only as a very high altitude repeater to relay information to some central data acquisition facility on earth, which then disseminates it to interested parties.

From a design perspective, It is significant that ARGOS DCLS places the position determining complexity of the system in the satellite and ground-based processing centers, as opposed to inside the transmitter/PTT. This allows the transmitter/PTT package to be smaller, lighter and less costly than if a positioning receiver for systems such as LORAN, TRANSIT or GPS were added.

Some years ago, the GEOSTAR satellite system was widely promoted as an RDSS capable of solving positioning problems in virtually all applications, replete with the usual claims of small hand-held terminals at bargain basement prices. Based on simulation testing and brass-board tests with aircraft to simulate orbiting satellites, GEOSTAR obtained a frequency allocation from the FCC. (Obtaining an experimental license and then subsequently being granted an operational license for frequency spectrum can be the toughest part of the whole process of getting into the RDSS business.) Then the usual problems began: launch problems, hardware problems, computer problems, and so on. Weeks stretched into months, months into years, and the promised GEOSTAR RDSS system was still not operational. Interestingly, an interim solution came in the form of a proposal by GEOSTAR to utilize the ARGOS system's unused capacity on a secondary service basis. GEOSTAR users got their badly needed position fixing service, and ARGOS was being supported more fully by utilizing some previously unused system capacity.

"In the future, commercial satellite tracking will most likely turn to the private sector for support in the development of low earth orbiting satellites..."

Telonics was asked to make a special configuration PTT for GEOSTAR to put on trucks. In operation, the PTT's transmissions were received by ARGOS receivers riding on NOAA polar-orbiter satellites. Location was then computed by ARGOS data processing facilities and fed to the GEOSTAR offices. The information was then provided to GEOSTAR subscribers. The system worked: subscribers were pleased with the product and ARGOS was able to broaden the support of their system without any negative impact on scientific users. In the long run, however, GEOSTAR was never able to make the transition from simply relaying positions via ARGOS or LORAN to becoming a true RDSS system, and they collapsed.

The GEOSTAR story reflects some aspects of the past which are pertinent today. There is a need for commercial satellite tracking and some applications can be undertaken today via ARGOS. There is a memorandum (March 1992) allowing ARGOS to provide five percent of the system's capacity to PTT's which do not have an environmental role (i.e. commercial applications). ARGOS's coverage is not continuous, however, and the limited capacity keeps the cost somewhat high. In the future, commercial satellite tracking will most likely turn to the private sector for support in the development of low earth orbiting (LEO) satellites which can meet ever increasing needs.

In the spring of 1992, there was an international conference on the allocation of radio frequencies. Frequencies were set aside on an experimental basis to allow the development of private commercial satellite systems to provide messaging and positioning services on a worldwide basis. An array of companies are attempting to take advantage of this business opportunity. Some are highly reputable with strong R&D capabilities and with the funding to seriously undertake the development of this technology. Other companies appear to be more interested in just issuing stock. The companies with engineering capabilities will develop the commercial systems over the next five to ten years, and the others will fall by the wayside.

The primary market appears to be for a system which can track and send messages to small terminals either placed in a vehicle or carried by a person. However, there are a myriad of specialty uses for low-voltage, low-power terminals. Many longtime ARGOS users will be looking to these new systems to provide services similar and additional to those they have today. Since the commercial terminals being developed for high volume markets are probably not going to be directly applicable to scientific and law enforcement uses, we are taking the first steps to develop the technology we need to take advantage of future capabilities.

Dave Beaty

Monitoring The Locations Of Fishing Vessels Using Satellites

The National Oceanic & Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Office of Enforcement, is the first law enforcement organization in the world to implement satellite technology successfully on a continuing basis.

The technology is used to monitor fishing vessel positions and uses data to detect civil and criminal fishing violations. Starting in 1988, in response to the growing threat of high seas salmon interception by foreign driftnet vessels, the Office of Enforcement successfully embarked on a satellite enforcement program to locate foreign fishermen catching U.S. origin anadromous species on the high seas of the North Pacific.

Background

The development during the past decade of a North Pacific high seas squid driftnet fishery by fishermen from Japan, Taiwan and Korea has been of growing concern to various U.S. and Canadian fishing and environmental interests. This concern stems from the fact that the fishery uses a fishing technique that results in the entanglement and death of marine resources of concern to U.S. interests, including non-target species of marine mammals, salmon and seabirds.

As a result of these concerns, the U.S. Congress passed the "Driftnet Impacting Monitoring, Assessment, and Control Act of 1987." This Act required that the Secretary of Commerce, in conjunction with various other departments, initiate negotiations with Japan, Korea, and Taiwan. These negotiations were aimed at developing cooperative monitoring and enforcement agreements concerning driftnet fishing. The monitoring agreements were designed to assess the fishery's impact on target (squid and albacore tuna) and non-target species, such as marine mammals. The enforcement agreements included measures for the effective monitoring and detection of violations. In addition, they called for the Secretary of Commerce to "...evaluate the feasibility of and develop appropriate recommendations for establishing a cooperative driftnet fishing vessel tracking system to facilitate efforts to monitor the location of driftnet fishing vessels."

During intense negotiations in 1988, 1989 and 1990 with officials from Japan, Korea, and Taiwan, the U.S. insisted that any agreement reached under the Driftnet Act must include driftnet vessel position monitoring using realtime satellite transmitting equipment. As negotiations progressed, representatives from NOAA's National Ocean Service (NOS), National Environmental Satellite Data and Information Service (NESDIS), and NMFS Office of Enforcement convened to study the application of driftnet vessel tracking systems using NOAA satellites. The task group agreed that systems were available to monitor the locations of fishing vessels. NMFS developed the parameters and NESDIS provided information on both the Geostationary Operational Environmental Satellite (GOES) and ARGOS systems.

On May 2, 1989, even before testing began, the U.S. and Canada reached an agreement with Japan. The Japanese agreed to consider installing satellite transmitters on their squid driftnet vessels in 1990, taking into account the results from U.S. and Japanese tests of the effectiveness of these devices on commercial fishing vessels.

In the summer of 1989, as the pace of negotiations intensified and worldwide pressure against the practice of driftnet fishery mounted, the U.S. transmitter test program began. Tests conducted on the GOES and ARGOS satellite transmitter systems demonstrated the ability of each to deliver accurate position information. The reliability of each type of vessel tracking system was excellent, although there were minimal differences between the satellite-generated position reports from ARGOS and the shipboard generated position reports from GOES. NMFS concluded that tracking fishing vessels using satellites was a practical and effective enforcement tool. The results were presented to each driftnetting country. In final analysis, the system which independently fixes position (ARGOS) was chosen by the participating countries.

On April 12, 1990, an international agreement among the U.S., Canada and Japan was signed That required realtime automatic satellite position fixing devices (transmitters) to be deployed on 100 percent of the Japanese squid and large-mesh driftnet fishing vessels operating in the North Pacific. These transmitters allowed automatic, realtime monitoring of the location and identity of each vessel by U.S., Canadian and Japanese officials. Similar agreements were reached with Korea and Taiwan in 1989.

Japan had approximately 450 vessels conducting driftnet operations in the North Pacific in 1990, all equipped with transmitters. All of Taiwan's 135 driftnet vessels and Korea's 188 were similarly equipped. Each country agreed to fund the purchase, installation, maintenance, and data processing costs involved in this program. They also agreed to provide U.S. authorities with realtime access to the satellite-generated position data.

Current Program

During 1990, we monitored approximately 780 driftnet vessels in the North Pacific. In 1991, the number decreased to about 600. UN General Assembly Resolution 46/215 called for a 50 percent reduction in effort in 1992 and a global moratorium on all large-scale pelagic driftnet fishing by December 31.

In July of 1991, at the peak of the foreign driftnet fishing operations, NMFS used data generated from this satellite tracking system to confirm that at least 21 vessels from Taiwan and 17 vessels from South Korea were fishing illegally in an area up to 75 nautical miles north of the legal boundary allowed by our bilateral driftnet agreements. U.S. Coast Guard ships and aircraft were dispatched to verify the violations.

As a result, Commerce Secretary Mosbacher certified to President Bush that under the Pelly Agreement to the Fishermen's Protective Act of 1967, Korea and Taiwan had diminished the effectiveness of our driftnet agreements by committing these violations. Under such certification, they were subject to sanctions restricting the importation of all their seafood products into the U.S. Commitments by both countries comply with UNGA Resolution 46/215, which allows them to avoid the sanctions under consideration by the Administration.

Future Program

Although the large high seas driftnet vessel satellite tracking program will end in 1992, fishery management officials and vessel owners from Japan, Korea and Taiwan have benefitted to various degrees from this program. Never before have they been able to accurately monitor the positions of their fleets in realtime. Most have expressed an interest in expanding this technology to other fleets. In fact, the United States is currently meeting with Japan, the Republic of Korea, the Peoples' Republic of China, Poland and Russia with the goal of forming an international convention for the conservation and management of fishery resources in the Central Bering Sea. Although the convention is not yet in place, the non-coastal states have agreed, as an interim measure, to place satellite-base vessel tracking systems on their vessels. Since poaching in the U.S. exclusive economic zone from the Central Bering Sea is a substantial problem, NMFS expects to receive position reports in realtime as it did under the driftnet agreements.

Building on these successes, the NMFS Office of Enforcement is embarking upon an aggressive satellite enforcement program, developing and promoting the use of satellite technology in the U.S. exclusive economic zone as well as in remote areas of the world where effective surface and aerial operations remain cost prohibitive. At present, satellite enforcement projects include operations for the Bering Sea, North, Central and South Pacific, and the Atlantic.

Conclusion

Many nations with limited resources are extremely interested in the ability to monitor vessel locations by satellite and associated technology capable of transmitting catch, weather, and other data on a realtime basis. NMFS is leading the way in using this technology for fisheries enforcement.

"Many countries are using our program as a model to implement their own vessel tracking and fleet management programs."

By every measure, the tracking program is a huge success. In no other area of the world does the U.S. or any other country monitor fishing vessels in greater numbers or with greater accuracy. Many countries are using our program as a model to implement their own vessel tracking and fleet management programs.

Steven Spinger

Editor's Note: *Steven Springer is Special Agent in charge of Enforcement Operations for NOAA. He has been involved with enforcing the Driftnet Act since it was enacted in 1987. Our thanks to him for contributing this article on a complex and politically sensitive subject of international concern.*

A Commitment to Law Enforcement

Telonics will continue to develop high quality products for specialized applications.

Providing technical support to the law enforcement community is not a new effort at Telonics. The program has been developing for a number of years and we are committed to helping agencies take advantage of emerging aerospace and communications technology.

The engineering required to transfer that technology into high quality products requires expertise in a number of areas – sensor technology and signal conditioning, digital and microprocessor hardware, and RF development. Telonics is a recognized leader in these areas and can provide the same engineering and manufacturing resources to law enforcement groups that we have traditionally provided to professional wildlife and environmental research scientists.

Jim Carter, Director of Special Projects, is responsible for the products we are currently developing for the law enforcement community. He works closely with customers through every stage of design and helps agencies define specifications tailored to their particular needs. Jim has been with Telonics for almost 10 years and has been building the Special Projects group for the past 6 years. His background with the company includes both assembly and refurbishments and he is experienced in every aspect of customer service, new product development and manufacturing. Jim holds a business degree from ASU and, prior to his work with us, was a commercial pilot for both corporate and scenic tour markets.

Scott Jarvis, Coordinator for Special Projects, has been with Telonics for almost 8 years. He is responsible for production and quality control on all law enforcement projects. His background with us includes management, purchasing, inventory control, quality control, assembly and final test.

The law enforcement products covered in this issue (SID-100 Seismic Intrusion Detector, Eagle Intrusion Detection System, TS-200 and 300 transmitters) are the first wave in the development of a more extensive product line. A number of other products are in development and one of the most intensive efforts is developing the new TR-3 Receiver. A sophisticated direction finding receiver, it is being developed specifically for the law enforcement community.

Regardless of application (wildlife, environmental, law enforcement), if you have questions about the products or technologies covered in this issue and are interested in how they might be adapted to your needs, please don't hesitate to call us. We enjoy hearing from you and your questions are always welcome.

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