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Market Survey Results for Alternate Sensor Communications

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Market Survey Results for Alternate Sensor Communications

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ABSTRACT

This document presents the results of a system analysis and market survey of commercially available alarm communication systems for potential use as an alternate sensor communication system. The communication systems surveyed include wireless radio frequency (RF) systems, spread spectrum systems, fiber optic systems, twisted pair/copper wire, cellular systems, and other types of communication equipment. All systems are commercially available, and most information was obtained by telephone conversations with the manufacturer, personal interviews at security conferences, and countless reviews of the manufacturers' data sheets. Many systems were identified, but only those that met a minimum set of system requirements were included. Other systems that appeared to be applicable usually did not provide adequate data encryption or could not interface directly to the system. While such features could be incorporated using additional hardware, doing so would make the system more expensive and conflict with the idea of purchasing a single unit that meets the minimum set of requirements. Several systems greatly exceed the scope of this project and utilizing such systems would mean investing in more capacity than is really needed.

Market Survey Results for Alternate Sensor Communications

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Market Survey Results for Alternate Sensor Communications

Introduction

Sandia National Laboratories Safeguards and Security Center (7400) tasked the Nuclear Security System Center (5800) to evaluate subsidiary communication methods of transmitting sensor information and make recommendations for implementing an alternate sensor communications system. The objective of this document is to present the results of a system analysis and market survey of commercially available alarm communication systems. Only those systems that report alarm/sensor information to a central control panel were considered. Many systems were identified, but only those that met a minimum set of system requirements were included in this document. An outline of the system requirements and specifications is presented in the next sections. A detailed definition of the system requirements can be found in *System Requirements and Specifications for Alternate Sensor Communications* dated June 20, 1994. Many other alarm communication systems were also identified but were not included on this market survey because of interface compatibility issues. While such interfaces could be incorporated with additional hardware, doing so would make the system more expensive and conflict with the idea of purchasing a single unit that would interface directly to Sandia's main Alarm Multiplexing Communication System (AMCS). Other candidate systems were either too simple or too complex to be implemented as an alarm/repository communication system. Some systems greatly exceeded the scope of this project; utilizing such systems would mean investing in more capacity than is really needed. Other systems could not interface to AMCS at all and were not considered.

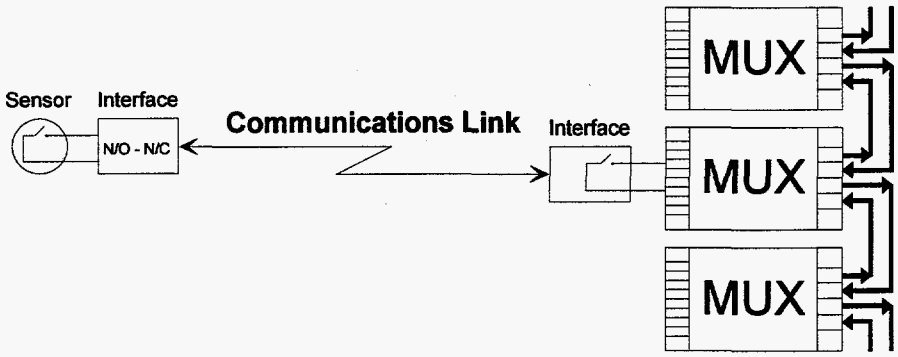
The communication systems described in this document are all commercially available and vary considerably in terms of cost, features, and capabilities. The systems surveyed include wireless radio frequency (RF) communication systems, spread spectrum communication systems, fiber optic communication systems, twisted pair/copper wire systems, cellular communication systems, and other communication equipment. Most of the information was obtained by telephone conversations with the manufacturer, personal interviews at security conferences, and countless reviews of the manufacturers' data sheets. In addition, other types of commercial alternate communications technologies and insights to wireless video transmission will be presented. Three possible system approaches will be explored in the next section. Each approach will take into account the level of line security required relative to system cost. Line protection should be addressed in terms of risk assessment relative to the security level of the asset being protected.

Approach

This section presents three approaches that address the interface compatibility of the alternate sensor communications. The following three approaches comply with the system architecture specified in the system requirements and specifications.

Approach 1

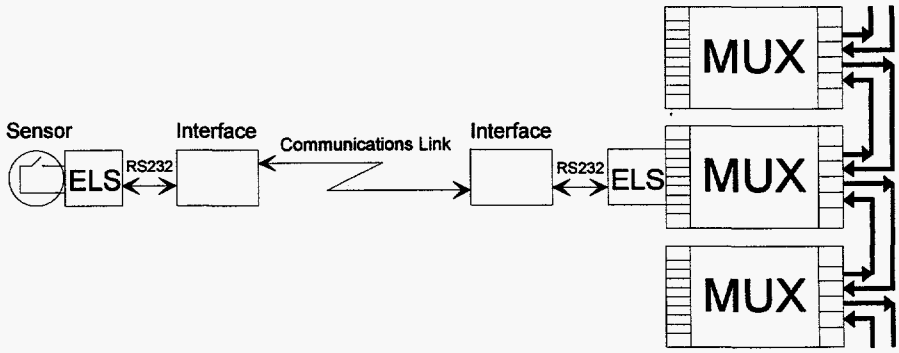
The first approach simply relays the sensor status (switch-closure status) to a receiver that is hardwired to an Alarm Multiplexer Communication System multiplexer (MUX) unit.



This approach is very simple to implement because it provides straight line relay connections between the sensor-communications interface and the communication-MUX interface. With this architecture, there are minimal or no requirements to engineer an interface to the system since many commercially available communication systems are already designed to relay switch-closure information. The output of the sensor will be a dry-switch closure that will connect directly to the sensor-communication interface via normally-open or normally-closed relays. The output of the communication-MUX interface is reversed and will connect directly to the input of the AMCS multiplexers via normally-open or normally-closed relays. Because of the simplicity of this system, the equipment cost is considerably lower than the next two approaches. However, this type of system architecture provides very limited communication line security because of built-in and existing characteristics of the manufacturer, e.g., spread spectrum, frequency hopping, etc.

Approach 2

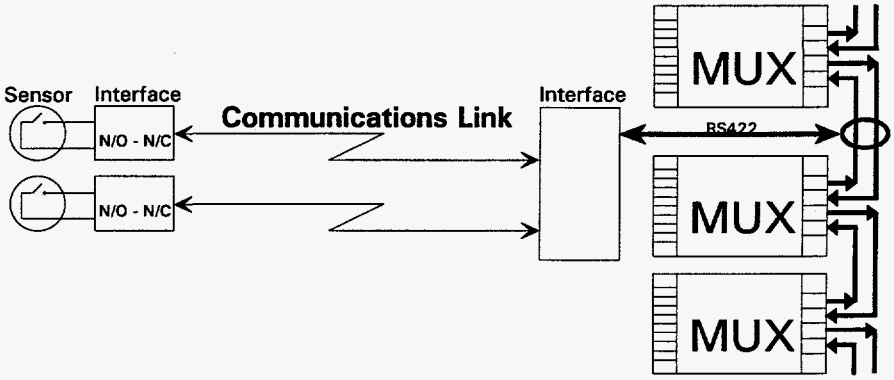
The second approach is similar to approach 1 except that an enhanced line security (ELS) module is placed between the sensor-communication and the communication-MUX interfaces. The ELS module encodes the sensor status and transmits the information using a specified format, usually RS-232 format. Another ELS module is necessary between the communication-MUX interface to decode the sensor information.



This approach is more complex than the first, but it provides a higher level of line security. The increased line security and the complexity of this approach also increase the cost of the system. With this approach, there may be some modifications or requirements to engineer a black-box interface to the multiplexer since the polling-side of the multiplexer requires switch-closure input.

Approach 3

The third approach is the most complex because there is a requirement to interface to the backbone link of AMCS. This approach will most likely require the development of a black-box interface to the AMCS. This link consists of a multiplexer-reporting interface on an RS-422 format. The sensor-communication interface is similar to the other two approaches, but the communication-MUX interface is bypassed by interfacing directly to the RS-422 communication link of AMCS.

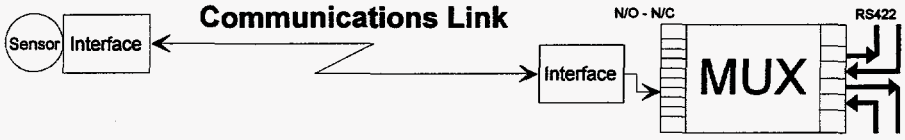


This approach provides the highest level of line security because the commercially available systems have built-in, proprietary line supervision and authentication algorithms. This enhanced line protection and complexity of this system is considerably higher than the other two, hence, a higher system cost. There will also be some additional cost involved in developing or engineering the interface to the RS-422 link of the AMCS system.

System Requirements

An outline of the system requirements and specifications is presented in this section for reference purposes. For a more detailed description of the requirements refer to the *System Requirements and Specifications for Alternate Sensor Communications* document. The set of requirements included in this report act only as a guideline to classify potential systems and screen out futile systems. Shortly after the market survey was initiated, it was apparent that no commercial system would meet 100 percent of our requirements without being modified. Thus it was recommended that this set of requirements be used only as a guideline for this market survey.

System Architecture



Interface Requirements

The system must be compatible with the existing AMCS multiplexer interface. As a basis, the communications link must interface to the sensor and the AMCS multiplexers via either normally-open or normally-closed relays. Alternatively, the communication-MUX interface may link directly to the reporting-side of the multiplexer using an RS-422 format.

Line Protection

The communication system must report a distinct alarm for the malfunction, short, open, or signal substitution. The line supervision must be continuously supervised to detect any system malfunctions or any attempts to short, open, or substitute bogus signals for the legitimate "no alarm" state. Alternatively, encryption may be used.

Tamper Protection

The communication system must report a distinct tamper-indicating alarm.

Multiplexing Capabilities

The communication-MUX interface/system must be able to multiplex a minimum of 8 communication transmitters/sensors.

Transmission Distance

The transmission distance must cover a minimal range of 500 feet (line-of-sight). Distance limitations may be overcome by utilizing repeaters or amplifiers in the transmission path.

Transmission Rate

The system must be compatible with the existing AMCS transmission scheme. Alternatively, the transmission rate shall be sufficiently fast to transmit/receive, within one second, the number of alarms equal to the number of discrete reporting sensors.

Polling Rate

The polling rate shall be sufficient to poll at the fastest rate consistent with the transmission rate and polling mechanism of the AMCS Multiplexers.

Portability/Size

The system shall be easily portable and must conform to the size limitations of the AMCS Multiplexer cabinets utilized by Department 7433.

Power Supply/Battery Backup

The transmitter shall operate on battery power for no less than 4 months and input voltages of 12 volts dc (VDC). The receiver/multiplexer shall operate on input voltages of either 12 volts dc (VDC) or 115 volts ac (VAC) with battery backup power of no less than 4 hours.

Commercial Systems Identified

Our goal was to identify commercially available communication systems that met 100 percent of our requirements. We soon discovered that no such commercial system was available (without making modifications to the system). Thus we were inclined to relax some of our requirements and specifications in order to perform this market survey. All of the systems included in this survey meet the majority of our requirements. The requirements that are not met are addressed in the "disadvantages" sections. Cost comparison tables are presented in pages 37 and 38. The following commercial sensor communication systems were identified and are included in this report.

Wireless Communication Systems

- Inovonics - MCR16/C200 System
- Northern Computers - SpreadCOM System
- ADEMCO - Wireless Alarm System
- Linear - Single-Channel System
- Linear - Multiple Channel System
- Linear - Supervised Wireless System
- Linear - Midrange System
- NAPCO - Magnum Alert Wireless System
- Visionic - SpiderAlert Wireless System
- ITI - SX5 Wireless Alarm System
- CRN - Radio Alarm System
- Seaboard - RC-2 Wireless System
- SNL - UNIMod System
- SNL - Authenticated Item Monitoring System
- SNL - WATCH System
- Intellitec - Lookout Dispatcher

Fiber Optic Communication Systems

- Math Associates - Fiberoptics Control Module
- American Fiber Tech - Status Control module
- Fibronics International - Fiberoptic Modems

Hardwire Communication Systems

- Puleo Electronics - Alarm Encoder/Decoder
- Litton Poly Science - Intelligent Transceiver
- Dantel - Multiple Transmitter Module

Other Communication Systems

- Cyplex - PowerPlex Module
- Stellar Systems - Monitoring Transponder
- Stellar Systems - EFS2 Encryption Module
- Scientific Technologies - 551X Modem
- United Marine - Intelligent Encryption Module

Many other communication systems were also identified but were not included on this market survey because of interface compatibility issues. Some systems provided their own interface but still required the purchase of additional equipment to interface to AMCS. Such interfaces could be accommodated with additional hardware, but doing so would make the system more expensive and conflict with the idea of purchasing a single unit that meets a minimum set of requirements. Other candidate systems were either too simple or too complex to be implemented as an alarm/repository communication system. These systems greatly exceeded the scope of this project; utilizing such systems would mean investing in more capacity than is really needed. Other systems could not interface to AMCS at all and were not considered.

Wireless Communication Systems

The following section contains all identified wireless radio frequency communication systems except cellular systems (they will be discussed in a separate section). This section also includes several wireless transmission systems that use different types of modulation techniques such as spread spectrum, frequency hopping, and frequency shift keying.

Inovonics - MCR16 Receiver/C200 Transmitter System

Method of Transmission	Radio frequency signals at 900 MHz using a dual frequency hopping method.
Brief Description of System	The system consists of a multichannel receiver for the remote monitoring of up to 16 independent universal transmitters. The transmitters may interface directly to any standard, normally-open or normally-closed contact sensors. The transmitters have a tamper protected case with low-battery warning and support for end-of-line resistors. The 900 MHz receiver decodes the transmitted signal and provides individual sensor status as well as individual relay output for each point. Additional information related to tamper, inactive, or low-battery status of each contact point can be obtained using a two-digit numeric LED status display. The system also offers a repeater for greater range of coverage.
System Components (Size)	C200 Universal Transmitter (6" X 1.25" X .75") C703 Receiver (13" X 10.25" X 2.5") C514 Device Programmer
Frequency Band	900 MHz region; dual frequency
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to normally-open, normally-closed inputs, and RS-232 output
Line/Tamper Protection	No line protection; tamper switches in transmitter case and receiver case
Multiplexing Capabilities	16 transmitters per receiver
Range of Transmission	2000 feet nominal; line-of-sight
Transmission/Polling Rate	Reporting period is programmable from 10 seconds to 6 hours
Power Supply	Transmitter - 4.5 V alkaline battery pack, 3-year life Receiver - 12 VDC, 14 VAC; battery backup, 4.6 Ah
Advantages	Low cost Accepts normally-open, normally-closed sensors, and RS-232 output Good range Repeaters also available High-frequency carrier Programmable report period Multiplexes up to 16 transmitters per receiver Access control devices also available
Disadvantages	No line protection or data encryption The only line protection is frequency hopping No external or backup power supply on transmitter

Northern Computers - SpreadCOM System

Method of Transmission	Radio frequency signals in the 902-928 MHz range using a spread spectrum technique.
Brief Description of System	The system consists of a Receiver/Control panel that accepts alarm status from an alarm zone transmitter. The transmitter supports four normally-closed alarm contacts and a supervisory alarm signal. The transmitter continuously monitors the status of the alarm contacts and sends out an alarm event during any status change. A supervisory signal is sent once every 30 seconds to the receiver.
System Components (Size)	N-4300 Zone Transmitter (6.5" X 3.5" X 1.5") N-4100 Central Transceiver Panel (16" X 14" X 4")
Frequency Band	902-928 MHz; Spread spectrum
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to normally-closed alarm contacts only
Line/Tamper Protection	No line protection; tamper switches in zone transmitter and central transceiver
Multiplexing Capabilities	64 transmitters
Range of Transmission	2000 feet; line-of-sight
Transmission/Polling Rate	Report period – 30 seconds Polling period – 45 seconds
Power Supply	Transmitter – 12 VDC from 110 VAC; battery backup, 4.6 Ah Receiver – 16 VDC, 12 VAC; 12 VDC battery backup, 3.0 Ah
Advantages	Spread spectrum transmission (partially secure signal transmission) Good range High-frequency carrier Multiplexes up to 64 transmitters per panel Remote units receive as well as transmit enabling the central control unit to poll the status of remote zones VAC power connection with battery backup
Disadvantages	High cost No line protection or data encryption Only normally-closed circuits are supported Polling and reporting periods are too long and not programmable

Ademco - Wireless Alarm Transmission System

Method of Transmission	Radio frequency signals at 350 MHz, transmitting over a single frequency.
Brief Description of System	The system consists of a receiver that can handle up to 64 zones. The transmitters can handle two or three zones independently and input normally-open or normally-closed circuits. The receiver can also handle transmitters that can be triggered by input voltage. The system provides a programming/learn mode that allows the system to be programmed with an ID code (from a range of over 16 million codes) for each transmitter.
System Components (Size)	5816 2-Zone Transmitter (3" X 1.5" X 1") 5817 3-Zone Transmitter (3" X 1.5" X 1") 5881 Receiver (8" X 5" X 1") 4140 XMPT2 Alarm Panel 4204 Relay Module
Frequency Band	350 MHz region; single frequency
System Architecture	Approach 1
Interface/Sensor Input	5816 Transmitter – 2 normally-open 5817 Transmitter – 2 normally-open, 1 normally-closed
Line/Tamper Protection	No line protection; tamper switches in transmitter case and receiver case
Multiplexing Capabilities	Up to 64 transmitters maximum per panel
Range of Transmission	400 feet; line-of-sight
Transmission/Polling Rate	Reporting period from 70 to 90 minutes; not programmable
Power Supply	Transmitter – 3 V lithium battery, no external power Receiver – 12 VDC, 16.5 VAC; battery backup, 4.0 Ah
Advantages	Low cost Multiplexes up to 16 transmitters per receiver
Disadvantages	No line protection or data encryption Limited range Single frequency operation Low-frequency carrier may not penetrate thin-metal walls Report period is too long and not programmable No external or backup power supply on transmitter

Linear - Single-Channel Wireless System

Method of Transmission	Radio frequency signals at 303.875 MHz, transmitting over a single frequency.
Brief Description of System	The system components are a single-channel transmitter and a single-channel receiver. The transmitter accepts normally-open or normally-closed circuits and encodes the signal using an eight-position DIP switch. The system consists of a single channel transmitter/receiver pair, thus it requires one transmitter and one receiver for each set of contact closures. The components, however, are very inexpensive.
System Components (Size)	D-21A N/O circuit transmitter (4.7" X 2.4" X .9") D-24A N/C circuit transmitter (4.7" X 2.4" X .9") DX-12 receiver (4.9" X 3.8" X 1.3")
Frequency Band	303.875 MHz; single frequency
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to normally-open and normally-closed circuits
Line/Tamper Protection	No line protection; tamper switches in transmitter case and receiver case
Multiplexing Capabilities	Single channel; one transmitter, one receiver per sensor contact
Range of Transmission	300 feet; line-of-sight
Transmission/Polling Rate	Transmitter needs to be externally activated for transmission. Continuous transmission while transmitter is activated.
Power Supply	Transmitter – 9 V battery, no external power supply Receiver – 11-24 VDC, 12-16 VAC
Advantages	Very low cost 256 selectable codes using an eight-position DIP switch
Disadvantages	No line protection or data encryption Limited range Requires one receiver for each transmitter Single-frequency operation Low-frequency carrier may not penetrate thin-metal walls Status reporting must be externally activated No external or backup power supply on transmitter

Linear - Multiple-Channel Wireless System

Method of Transmission	Radio frequency signals in the 303.875–318.000 MHz range, transmitting over a multiple-channel spectrum.
Brief Description of System	The system consists of two-channel, four-channel, or eight-channel receivers that accept signals from the previous Linear D21A and D24A transmitters. The transmitter accepts normally-open or normally-closed circuits and encodes the signal using an eight-position DIP switch.
System Components (Size)	D-21A N/O circuit transmitter (4.7" X 2.4" X .9") D-24A N/C circuit transmitter (4.7" X 2.4" X .9") D-2, D4, D8 Receivers (4.8" X 4.2" X 1.3")
Frequency Band	303.8–318 MHz; multiple-channels
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to normally-open and normally-closed circuits
Line/Tamper Protection	No line protection; tamper switches in transmitter case and receiver case
Multiplexing Capabilities	Up to 8 transmitters per receiver
Range of Transmission	300 feet; line-of-sight
Transmission/Polling Rate	Transmitter needs to be externally activated for transmission. Continuous transmission while transmitter is activated.
Power Supply	Transmitter – 9 V battery, no external power supply Receiver – 11-24 VDC, 12-16 VAC
Advantages	Low cost 256 selectable codes using an eight-position DIP switch Multiple channels
Disadvantages	No line protection or data encryption Limited range Low-frequency carrier may not penetrate thin-metal walls Status reporting must be externally activated No external or backup power supply on transmitter

Linear - Supervised Wireless System

Method of Transmission	Radio frequency signals at the 303.8–315 MHz range using a supervised multiple-channel method.
Brief Description of System	The system consists of a receiver panel that accepts up to 32 supervised transmitters which connect to normally-open and normally-closed inputs. The transmitter encodes the signal using an eight-position DIP switch. The receiver interfaces with virtually any type of hardwire panel and annunciates six different transmitter conditions.
System Components (Size)	ST Transmitter (3.95" X 2.4" X .9") SSR-32 Receiver (6.55" X 7.92" X 1.28")
Frequency Band	303.8–315 MHz
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to normally-open and normally-closed circuits
Line/Tamper Protection	No line protection; tamper switches in transmitter and receiver
Multiplexing Capabilities	Up to 32 transmitters per receiver Eight output zones
Range of Transmission	300 feet; line-of-sight
Transmission/Polling Rate	Reporting period every 1.2 hours; not programmable
Power Supply	Transmitter – 9 VDC battery, no external power supply Receiver – 12 VDC, no external power supply
Advantages	Low cost 256 selectable codes using an eight-position DIP switch Multiplexes up to 32 transmitters per receiver
Disadvantages	No line protection or data encryption Limited range Low-frequency carrier may not penetrate thin-metal walls Report period too long, not adjustable or programmable No external or backup power supply on system

Linear - Midrange Wireless System

Method of Transmission	Radio frequency signals at 27.145 MHz using high-power, single-channel transmission.
Brief Description of System	The system consists of one-channel, four-channel, or eight-channel transmitter and receiver combination. The system accepts normally-open and normally-closed circuits and provides an ID code (from over 64,000 codes) for each input. The system is also weather-resistant for exterior applications.
System Components (Size)	MR161T/MR164T/MR168T Transmitters (4.2" X 2.5" X 9.75") MR161R/MR164R/MR168R Receivers (4.2" X 2.5" X 9.75").
Frequency Band	27.145 MHz
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to normally-open and normally-closed circuits
Line/Tamper Protection	No line protection; tamper switch in transmitter and receiver
Multiplexing Capabilities	Up to 8 transmitters per receiver Over 64,000 codes
Range of Transmission	From 3/4 to 5 miles; line-of-sight
Transmission/Polling Rate	Transmitter needs to be externally activated for transmission. Continuous transmission while transmitter is activated
Power Supply	Transmitter – 9 AAA batteries or 12–13.5 VDC external power supply Receiver – 12-13.5 VDC from external power supply
Advantages	Good range VAC power supply with battery backup
Disadvantages	High cost No line protection or data encryption Low-frequency carrier may not penetrate thin-metal walls Status reporting must be externally activated

NAPCO - Magnum Alert Wireless System

Method of Transmission	Radio frequency signals in the UHF radio band using a spread spectrum technique.
Brief Description of System	The system consists of a receiver panel that handles up to 14 transmitters. The transmitters provide a powerful signal that penetrates through common obstructions and has a free-air maximum range of 500 feet. The transmitters also provide up to 16,000 encrypted link codes with a compressed data format. The system is based on a unique, super spread spectrum wireless receiver that incorporates an auto-learn mode that memorizes the transmitters' codes. The system is also fully-supervised. The transmitters communicate the alarm status, supervisory data, tamper status, and low battery status.
System Components (Size)	T1000WD Transmitter (3.3" X 1.5" X .88") R1000 Receiver (5.5" X 3.1" X 1.75") R1008e Control panel (4.5" X 5.2" X .9")
Frequency Band	UHF radio frequency
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to normally-open and normally-closed circuits
Line/Tamper Protection	No line protection; tamper switches in transmitter and receiver
Multiplexing Capabilities	Up to 14 transmitters per receiver
Range of Transmission	3500 feet; line-of-sight
Transmission/Polling Rate	Reporting period every four hours; not programmable
Power Supply	Transmitter – Long life lithium batteries, no external supply Receiver – 12 VDC lithium battery
Advantages	Low cost Spread spectrum transmission (partially secure signal transmission) Multiplexes up to 14 transmitters per receiver Good range
Disadvantages	No line protection or data encryption Low-frequency carrier may not penetrate thin-metal walls Report period not adjustable No external or backup power supply on transmitter

Visionic - SpiderAlert Universal Wireless System

Method of Transmission	Radio frequency signals at 315 MHz over a single-channel transmission.
Brief Description of System	The system consists of a receiver that can multiplex up to 4 transmitters. The transmitters accept normally-open and normally-closed circuits. The system also offers a repeater for greater range coverage. The system also requires a central control unit that is used to program the transmitters and receivers.
System Components (Size)	WT-100 Transmitter (2.5" X 4.25" X 1.0") WR-200 Receiver (2.5" X 4.25" X 1.0") WRP-500 Repeater WMX-16 Multiplexer
Frequency Band	315 MHz; single frequency
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to normally-open and normally-closed circuits
Line/Tamper Protection	No line protection; tamper switches in transmitter and receiver
Multiplexing Capabilities	Up to 4 transmitters per receiver
Range of Transmission	500 feet; line-of-sight
Transmission/Polling Rate	Transmitter needs to be externally activated for transmission. Continuous transmission while transmitter is activated.
Power Supply	Transmitter – 9 V alkaline battery; no external power supply Receiver – 12 VDC from external power supply
Advantages	Low cost Repeaters available
Disadvantages	No line protection or data encryption Limited number of transmitters per receiver Low-frequency carrier may not penetrate thin-metal walls Status reporting must be externally activated No external or backup power supply on transmitter

Interactive Technologies Inc. - SX5 Wireless Alarm System

Method of Transmission	Radio frequency signals at 319.5 MHz, transmitting over a single frequency.
Brief Description of System	The system is composed of a receiver panel that receives the transmitted signal from a single-channel transmitter. The transmitter may interface to normally-open or normally-closed circuits. The system also provides a learning mode technology that allows the system to program each transmitter with a code from a range of over 16 million codes.
System Components (Size)	SX5 System, 60-135 Alarm Transmitter (no data) SX5 System, 60-125 Receiver Panel (no data)
Frequency Band	319.5 MHz; single frequency
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to a single normally-open or normally-closed input
Line/Tamper Protection	No line protection; tamper switches in transmitter and receiver
Multiplexing Capabilities	Up to 61 transmitters maximum
Range of Transmission	1000 feet nominal; line-of-sight
Transmission/Polling Rate	Reporting period every 69 minutes; not programmable
Power Supply	Transmitter – 3 V lithium battery; no external power Receiver – 12 VDC. 16.5 VAC; battery backup, 4.0 Ah
Advantages	Low cost Adequate range Multiplexes up to 61 transmitters per receiver
Disadvantages	No line protection or data encryption Single frequency operation Low-frequency carrier may not penetrate thin-metal walls Report period not adjustable or programmable No external or backup power supply on transmitter

CRN - Radio Alarm Transmission System

Method of Transmission	Radio frequency signals in the 450–512 MHz range using a frequency shift key algorithm.
Brief Description of System	The system consists of a transmitter and a receiver pair. The transmitters consist of a data encoder and an RF transmitter that sends a supervisory test signal at programmable intervals. Input channels are triggered by voltage input (6 to 12 VDC), contact closure, or TTL. There are three transmitter models with 6-channel mode, 12-channel mode, and a total-data transfer mode. The receiver receives the signal, decodes it, and generates a signal level output.
System Components (Size)	CRN6E and CRN12E Transmitters (2.875" X 7.825" X 1.625") CRNRU Receiver (4.2" X 2.5" X 9.75")
Frequency Band	450–512 MHz
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to voltage input (6–12 VDC), contact closures, and TTL
Line/Tamper Protection	No line protection; tamper switches in transmitter and receiver
Multiplexing Capabilities	Up to 8 transmitters per receiver
Range of Transmission	Up to 6 miles; line-of-sight
Transmission/Polling Rate	Reporting period programmable from 10 minutes to several hours
Power Supply	Transmitter – 12.5 VDC; no external power supply Receiver – 12–13.5 VDC from external power supply
Advantages	Provides proprietary line supervision Accepts voltage input, contact closures, and TTL Good range Repeaters also available to extend rage of coverage High-frequency carrier
Disadvantages	Very high cost Report period too long Low-frequency carrier may not penetrate thin-metal walls No external or backup power supply on transmitter

Seaboard - RC-2 Series Wireless System

Method of Transmission	Radio frequency signals in the 450–470 MHz range using a frequency shift key algorithm.
Brief Description of System	The system consists of up to 243 individually addressable receivers. Each receiver accepts up to 40 transmitters. The entire system can handle up to 10,000 transmitters. The transmitter accepts normally-open or normally-closed circuits. The transmitter sends a unique coded signal to the receiver; the receiver decodes the information and activates one of eight integral relays. An RS-232 output port provides the communications to an annunciator/computer.
System Components (Size)	RC-1/TX Transmitter (5" X 2.75" X 1.2") RC-1/RX Receiver (11.25" X 15.25" X 4.25")
Frequency Band	450–470 MHz
System Architecture	Approach 3
Interface/Sensor Input	Interfaces to normally-open, normally-closed, and voltage input (6–12 VDC)
Line/Tamper Protection	Proprietary line supervision; tamper switches in transmitter and receiver
Multiplexing Capabilities	Up to 243 transmitters per receiver
Range of Transmission	Up to 30 miles
Transmission/Polling Rate	Status reporting is triggered by voltage input
Power Supply	Transmitter – 12.6 VDC @ .75 A, 4 Ah batteries with 110 VAC charger Receiver – 12.6 VDC battery or external power supply
Advantages	Provides proprietary line supervision Excellent range Repeaters also available to extend range of coverage Multiplexes up to 243 transmitters per receiver VAC power supply with battery backup
Disadvantages	Very high cost Status reporting must be externally activated Low-frequency carrier may not penetrate thin-metal walls

SNL - Universal Network Interface Module

Method of Transmission	Radio frequency signals in the narrow UHF band and VHF range.
Brief Description of System	The system consists of a transceiver unit that acts as a transmitter, receiver, and repeater to communicate alarm status. The transmitter wakes up every 1/8 second and transmits a data encryption standard (DES) encoded signal of the alarm status to the receiver. The transmitter has six relay inputs that can interface to normally-open or normally-closed inputs. The receiver performs the reverse function with six relay outputs. The receiver unit has the capability to talk RS-485 to provide sensor status from up to 2000 transmitters. The report period is dependent on the number of transmitters reporting to the receiver. The units also have programmable system power capabilities that allows the devices to utilize their power more efficiently.
System Components (Size)	Transmitter/Receiver/Repeater (4" X 2" X 1.5")
Frequency Band	UHF (450–500 MHz) and VHF (140-174 MHz)
System Architecture	Approach 1, approach 2, and approach 3
Interface/Sensor Input	Interfaces to normally-open, normally-closed inputs, and RS-485 output
Line/Tamper Protection	Provides DES line protection; no tamper indicating switch is implemented in the enclosure at this time, but one of the six relays could act as a tamper indicating switch.
Multiplexing Capabilities	Up to 2000 reporting transmitters
Range of Transmission	Up to 50 miles at maximum power; line-of-sight
Transmission/Polling Rate	Reporting period programmable from 0.125 second up to several hours
Power Supply	Transmitter/receiver - Eight AA batteries; no external power supply
Advantages	Moderate cost Provides DES line encryption Accepts normally-open, normally-closed sensors, and RS-485 output Excellent range Repeaters available to extend range of coverage Multiplexes up to 2000 transmitters to a single receiver
Disadvantages	No tamper protection in transmitter/receiver Low-frequency carrier may not penetrate thin-metal walls No external or backup power supply on unit

SNL - Authenticated Item Monitoring System (AIMS)

Method of Transmission	Radio frequency signals in the 900 MHz range using a frequency hopping technique.
Brief Description of System	The system consists of authenticated alarm transmission modules. The transmitter can interface to normally-open or normally-closed inputs and relay an authenticated code to the receiver that contains the sensor status. The receiver decodes the data and relays the information to a central processing unit using an RS-422 link.
System Components (Size)	Transmitter (2.5" X 2.5" X 2") Receiver–portable computer unit ≈ (10.0" X 12.0" X 6")
Frequency Band	900 MHz
System Architecture	Approach 3
Interface/Sensor Input	Interfaces to normally-open, normally-closed circuits and RS-232 output
Line/Tamper Protection	Proprietary line authentication; tamper switches in transmitter and receiver
Multiplexing Capabilities	Up to 2048 reporting transmitters
Range of Transmission	2000 feet; line-of-sight
Transmission/Polling Rate	Polling rate is user programmable from 10 seconds
Power Supply	Transmitter - One AA size lithium battery; no external or backup power Receiver - 12 VDC, 14 VAC; battery backup @ 4.6 Ah
Advantages	Provides proprietary line authentication Frequency hopping for higher line security Accepts normally-open, normally-closed sensors, and RS-232 output Good range Multiplexes up to 2048 transmitters to a single receiver High-frequency carrier
Disadvantages	Relatively high cost No external or backup power supply on transmitter

SNL - Wireless Alarm Transmission of Container Handling (WATCH) System

Method of Transmission	Radio frequency signals in the 900 MHz range using a frequency hopping technique.
Brief Description of System	The WATCH system consists of a wireless universal RF transmitter/receiver pair. The WATCH system is the unauthenticated version of AIMS. The transmitter interfaces to normally-open or normally-closed contacts/sensors. The receiver can collect data from up to 16 transmitters and generates an array of switch closures. With the assistance of an LED status array on the receiver, the status of each specific sensor can be determined.
System Components (Size)	Transmitter (4" X 2.25" X 1") Receiver – 16-Channel Receiver (13" X 10.25" X 2.5)
Frequency Band	900 MHz region; dual frequency
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to normally-open and normally-closed circuits and RS-232 output
Line/Tamper Protection	No line protection; tamper switches in transmitter and receiver
Multiplexing Capabilities	The receiver can collect data from up to 16 transmitters. The receiver provides 12 normally-open switches, 4 type-C switches, and a two-digit numeric LED status display.
Range of Transmission	2000 feet; line-of-sight
Transmission/Polling Rate	Polling rate is user programmable from 10 seconds up to 6 hours
Power Supply	Transmitter - AA size lithium battery, no external power supply Receiver - 12 VDC, 14 VAC; battery backup @ 4.6 Ah
Advantages	Low cost Frequency hopping for higher line security Accepts normally-open, normally-closed sensors, and RS-232 output Good range Multiplexes up to 16 transmitters per receiver High-frequency carrier
Disadvantages	No significant line protection or data encryption No external or backup power supply on transmitter

Intellitech - Lookout Dispatcher

Method of Transmission	Radio frequency signals in the UHF range of 450–470 MHz.
Brief Description of System	The system consists of a receiver that handles up to 12 transmitters. The transmitters support a wide range of commercially available sensors and normally-closed, and normally-open switch closures. The receiver provides eight DC outputs that can be set to activate on a specific alarm condition. The system can also be interfaced to many conventional alarm panels.
System Components (Size)	Transmitter (8" X 3" X 1.5") Receiver (15" X 11" X 3.5")
Frequency Band	450–470 MHz
System Architecture	Approach 3
Interface/Sensor Input	Eight dual polarity supervised inputs and 4 unsupervised switch closures
Line/Tamper Protection	No line protection; tamper switches in transmitter and receiver
Multiplexing Capabilities	Up to 12 transmitters per receiver
Range of Transmission	Up to 1 mile
Transmission/Polling Rate	Reporting period programmable from 15 seconds to several hours
Power Supply	Transmitter - Two 9 V batteries; no external power supply Receiver - 12 Volt DC, 12 VAC; battery backup, 7.5 Ah
Advantages	Good range Repeaters also available Multiplexes up to 12 transmitters per receiver Programmable report period
Disadvantages	Very high cost No line protection or data encryption Low-frequency carrier may not penetrate thin-metal walls No external or backup power supply on transmitter

Fiber Optic Communication Systems

This section describes potential fiber-optic alarm communication candidate systems and includes only systems that will report alarm status using a fiber optic communication link. This section does not, however, include RS-232/422 format fiber optic transmission systems; there are numerous types of RS232/422 fiber-optic systems in the market and are too many to list. Rather, this section concentrates on inexpensive alarm-reporting fiber-optic systems.

Math Associates - Fiberoptic Status Control Module

Method of Transmission	Fiber optic communication link between modules; reporting module is hard-wired to the sensor.
Brief Description of System	The system takes a TTL level, DTL level, or a switch closure and transmits the change to a receiver using fiber optic link. The input level is monitored on the output port of the receiver and activates an alarm interface. These devices will interface to practically any alarm control panel.
System Components (Size)	SC 1000A source module (3" X 1.5" X 1") RC 1000A receiver module (3" X 1.5" X 1")
Frequency Band	N/A
System Architecture	Approach 1
Interface/Sensor Input	Eight TTL or DLL level inputs; or eight contact closures
Line/Tamper Protection	J-box enclosures with signal lines in metal conduit recommended. Normally-closed or high-TTL level for output status recommended
Multiplexing Capabilities	These units may be used in conjunction with one another but must have external control over addressing and decoding locations.
Range of Transmission	850 nm or 1300 nm options available
Transmission/Polling Rate	N/A
Power Supply	Transmitter/receiver modules - 12 VDC/VAC or battery available
Advantages	Relatively low cost per channel Available in Analog Current Loop configuration for line supervision Battery backup available
Disadvantages	Cost of module does not include the cost of the fiber cable No line supervision; needs to be added externally (conduit)

American Fiber - Fiberoptic Status Control Modules

Method of Transmission	Fiber optic link between communication modules. Hardwires between the reporting module and the sensor.
Brief Description of System	The system consists of a fiber optic source module and a receiver module. The system multiplexes up to 8 channels of contact closures or TTL on one multimode glass fiber. The source module accepts either TTL level or a switch closure and transmits the status from the transmitter to the receiver using fiber optics. The receiver module then converts the fiber light into a TTL or switch closure output.
System Components (Size)	MT-80 Transmitter module (5.5" X 2.4" X 1.12") MR-80 Receiver module (6" X 3.75" X 1.2")
Frequency Band	N/A
System Architecture	Approach 1
Interface/Sensor Input	Interfaces to either TTL or contact closures
Line/Tamper Protection	No line protection. J-box tamper enclosures with signal lines in metal conduit recommended.
Multiplexing Capabilities	8-channel TTL or 8-channel contact closures rated at 0.5 A/channel
Range of Transmission	850 nm or 1300 nm options available
Transmission/Polling Rate	2 milliseconds maximum
Power Supply	Transmitter/Receiver Modules - 12 VDC/VAC or battery available
Advantages	Low cost per channel Good transmission distance
Disadvantages	Cost of module does not include the cost of the fiber cable No built-in line supervision; needs to be added externally No tamper protection mechanism

Fibronics International - Miniature Fiberoptic and Twisted Pair Modems

Method of Transmission	Multimode fiber optic or twisted pair copper.
Brief Description of System	These modems are used for local data distribution, providing full or half duplex, synchronous or asynchronous connections. The modems feature a DTE/DCE switch and are available with either male or female connectors. This is a relatively common product; several sources are available.
System Components (Size)	FM060 asynchronous fiberoptic modem. FM065 synchronous fiberoptic modem. FM049 asynchronous twisted pair modem. FM048 synchronous twisted pair modem.
Frequency Band	N/A
System Architecture	Approach 1
Interface/Sensor Input	RS-232 digital data
Line/Tamper Protection	None
Multiplexing Capabilities	None
Range of Transmission	1.25 miles on multimode fiber or IBM type 1, 2 copper cable
Transmission/Polling Rate	Data rates; up to 19.2 Kbaud
Power Supply	None required
Advantages	Requires no power supply Very small size: 1" x 2" x 4" Other access control devices available
Disadvantages	Very high cost per channel No line protection or data encryption No tamper protection

Hardwire Communication Systems

This section describes potential hardwire, twisted-pair type of alarm reporting systems. This section, however, is not an all inclusive RS-232/422 format survey; there are numerous types of RS232/422 hardwire, twisted-pair systems in the market and are too many to list. Rather, this section contains some hardwire type of alarm reporting systems that will transmit RS-232/422 format for the application of approach 2. These alarm systems are included only for risk assessment and line security comparisons. These systems can also be used with the (Approach 2) enhanced-line security modules to increase the sensor-MUX line protection.

Puleo Electronics, Inc. - Alarm Encoder/Decoder Reporting Link

Method of Transmission	RS-232 data communications over twisted pair.
Brief Description of System	Remote alarms are multiplexed into an asynchronous RS-232 data circuit. An encoder chassis monitors and continuously reports the status of up to 48 discrete alarm inputs over an RS-232 data link to a decoder chassis. The decoder chassis drives a corresponding set of up to 48 outputs whose status reflects those of the encoders' inputs. The open collector outputs can sink a maximum of 200 mA each. Optional dry contact relay output boards may be used for further isolation and increased current carrying capability.
System Components (Size)	PE903-016 rack mountable encoder with power supply and modem PE903-017 rack mountable decoder with power supply and modem
Frequency Band	N/A
System Architecture	Approach 2
Interface/Sensor Input	Either open collector or contact closures
Line/Tamper Protection	Upon loss of encoder signal, the decoder outputs can be turned off or placed in a sleep mode
Multiplexing Capabilities	48 alarm inputs multiplexed over a single RS-232 data link
Range of Transmission	4 to 5 miles
Transmission/Polling Rate	0.13 seconds at 1200 baud
Power Supply	11 to 13 VDC, 125 mA, 5% or better regulation
Advantages	Encodes/decodes up to 48 alarms over a single RS-232 data link Communications link loss detection Significant distances achievable depending on the type of RS-232 modem Near instantaneous alarm reporting
Disadvantages	Very high cost No tamper protection No external or backup power supply on unit

Litton Poly Science - Intelligent Transceiver Node

Method of Transmission	Signal communication over a twisted pair to RCP or other ITN.
Brief Description of System	The system consists of an intelligent transceiver electronic panel that can be remotely located. It interfaces to alarm input points, control outputs, access control inputs, and other devices. This transceiver connects to its master controller or other alarm communication panels. The transceiver has an on-board intelligent database and multiplexes up to 8 alarm input zones. Each zone has the expansion capability of up to 24 contact points.
System Components (Size)	SP3981 Intelligent Transceiver Node (10.25" X 3.5" X 5") SP3980 Communications Port Contender (18" X 12" X 5") SP3930 CPU Control Unit (10.25" X 3.5" X 5")
Frequency Band	N/A
System Architecture	Approach 1
Interface/Sensor Input	Packaged, programmable, hard-wire interface
Line/Tamper Protection	Built-in feature of this system, it is built into each unit at the module level
Multiplexing Capabilities	Four SP3981 ITN per SP3930 CPU Control Unit
Range of Transmission	Twisted pair ≈ 1000 ft Fiber optic conversion in the 850 to 1300 nm range
Transmission/Polling Rate	Programmable
Power Supply	8–25 VDC; lithium battery backup
Advantages	Built-in line supervision and tampering Battery backup
Disadvantages	Relatively high cost No multiplexing capabilities

Dantel, Inc. - Multiple Alarm Transmitter/Control Point Module

Method of Transmission	Half duplex, asynchronous, continuous data stream over a single twisted pair.
Brief Description of System	Discrete alarms (contact closures) from remote sites are reproduced as contact closures at a central location. The two modules used are the multiple alarm transmitter (MAT) and the control point module (CPM). The MAT, available with either 16- or 32-alarm inputs, continuously transmits the status of the alarm points to the CPM over a single twisted-pair copper cable. When an alarm in received by the MAT, the corresponding control point on the CPM is activated, thereby reproducing the alarm as a contact closure. A single CPM will reproduce up to 16 discrete alarms.
System Components (Size)	Model 46009 MAT with 32 ground activated alarm inputs Model 46010 MAT with 16 ground activated alarm inputs Model 46028 CPM with 16 remotely operated control outputs
Frequency Band	N/A
System Architecture	Approach 1
Interface/Sensor Input	Ground activated alarm inputs. Needs 300 uA sink to activate
Line/Tamper Protection	None
Multiplexing Capabilities	Up to 32 alarm channels are multiplexed over a single twisted pair. Any number of MATs or CPMs may be collocated with up to 14 modules on the same chassis.
Range of Transmission	Dependent on type of modem used; (50 feet with no modem)
Transmission/Polling Rate	Delay time for transmitting an alarm through this medium is almost negligible; (far less than 1 second).
Power Supply	48 VDC modular power supply
Advantages	Loss of communications link detection Good transmission distances through flexible system design Reproduces 32-alarm switch closures over a single twisted pair Almost instantaneous alarm reporting
Disadvantages	High cost No line protection or data encryption No tamper protection No backup power supply on unit

Cellular Communication Systems

This section describes cellular communication systems applicable to alarm reporting systems. The primary application for cellular technology to alarm systems appears to be as a backup for hardwire telephone-line-based systems. Because of this limitation and the high cost of cellular equipment, all cellular alarm communication systems were omitted from this market survey.

Cellular Communication Systems

Method of Transmission

Most cellular alarm communication systems use proprietary cellular networks for alarm transmission.

Brief Description of a Typical System

A typical cellular alarm transmission system consists of a panel that accepts a wide variety of inputs, from switch closures to RS-485 inputs. The control panel is an intelligent device that typically calls in the alarm status on a preprogrammed or a voltage trigger basis. The controller panels are usually very expensive devices that input a large number of contacts. Besides paying for the expensive controller panels, the subscriber must also pay for air transmission time.

Advantages

No advantages to the use of this technology were identified.

Disadvantages

The primary application for cellular technology to alarm systems appears to be as a backup for hard-wired telephone-line-based systems. High cost is also another disadvantage; it becomes very expensive for large alarm systems because of equipment cost and transmission time.

Laser Communication Systems

This section describes laser communication systems; although no commercially available systems were identified. This section provides some insight as to how a laser system could be applied for repository alarm reporting.

Laser Communication Systems

Method of Transmission

The approach to a laser-based alarm communication system was investigated. The method analyzed made use of laser diodes to transmit information to a centralized receiver within a line-of-sight area. This information would then be relayed using another laser diode or hard-wired to a control panel.

Brief Description of a Typical System

No such system could be identified. However, several components that perform one or more functions as described above were identified. Because the requirements and application specifications of our system, a laser communication system was not available at this time for alternate sensor/alarm reporting.

Advantages

Laser diodes, transmitters, and receivers are very inexpensive.

Disadvantages

Transmission must be line-of-sight.
A system that meets most of our requirements is not yet commercially available.

Power-Line Communication Systems

This section describes power-line communication systems. The concept is to send alarm status signal using power-line transmission systems. The alarm signal would be superimposed on the power lines at the source and reversibly extracted at its destination.

Cyplex - PowerPlex Communication Module

Method of Transmission	The Power-Plex power line communication modem uses an adaptive frequency-hopping spread-spectrum communication technology.
Brief Description of System	The system consists of two modules. One module is the actual modem that generates the spread spectrum signals that are superimposed in the power lines. The other module is a line coupler that allows the coupling of the communication modem to the VAC power lines. The system can transmit RS-232 format and can be configured to transmit other types of formats. The system is designed specifically for supervisory control and data collection applications.
System Components (Size)	Power-Plex 1000 Module (2.6" X 1.5" X .360") PoweLink Coupler (2.6" X 1.5" X 1.025")
Frequency Band	9 kHz to 95 kHz
System Architecture	Approach 1
Interface/Sensor Input	Possibly switch closure inputs; interface not fully defined
Line/Tamper Protection	None
Multiplexing Capabilities	None
Range of Transmission	Unknown (Range is also limited by the number of transformers in the path)
Transmission/Polling Rate	Transmission rate is 300 bps and 1200 bps
Power Supply	+5 VDC @ 150 mA; -5 VDC @ 100 mA
Advantages	Low cost per input Small design/packages
Disadvantages	The system may require the design of our own interface to the power-line coupler. There are too many communication and interface unknowns about this system and the design effort has not been fully investigated at this time.

Other Communication Systems

This section provides information on other alarm reporting systems or products encountered while performing this market survey. Some of these systems or devices must be implemented with the approaches discussed in this document. This market survey was projected to cover all applicable communication systems. Many categories of systems were identified, but some did not or could not lend themselves to our requirements or to the AMCS interface. Some equipment was necessary to provide adequate line security or interface to the existing AMCS system. The following devices provide this kind of requirement mitigation.

Stellar Systems - Remote Control Transponder

Method of Transmission	Fiber optic, RS-422, or RS-232C communications to a multiplexer control unit at 300-19,200 baud.
Brief Description of System	This remote data unit (RDU) performs an identical function to the existing TROS-8/4 currently used by Sandia. The remote control transponder could be used to emulate the alarm collection from different types of repository sensors. This alarm monitoring and communication device typically communicates with higher level systems.
System Components (Size)	RDU-300 Monitoring Transponder
Frequency Band	N/A
System Architecture	Approach 2
Interface/Sensor Input	Switch closures to four input devices
Line/Tamper Protection	4 inputs are line supervised; tamper protection built into the enclosures
Multiplexing Capabilities	Up to 256 alarm input per RDU
Range of Transmission	Depends on site requirements
Transmission/Polling Rate	Data rate; 300 to 9600 baud
Power Supply	9-24 VDC @ 110 mA; no battery backup
Advantages	Partial proprietary line supervision Very versatile Multiplexes up to 256 transmitters per receiver
Disadvantages	High cost Only 4 inputs per unit are line supervised No battery backup

Stellar Systems - EFS2 Encryption System

Method of Transmission	Fiber-optic, modem, RF, RS-422, or RS232 operation.
Brief Description of System	The EFS2 encryption system is a point-to-point alarm transmission system that protects the sensor communication link by converting the information into an encrypted signal. The system consists of two EFS2 transceivers. Sensor information is converted into a DES encrypted data stream and transmitted to another EFS2 module which decodes the encrypted sensor information. The modules can talk to each other using copper wires, telephone modems, dual fiber optic cables or radio frequency.
System Components (Size)	EFS-2 encryption modules (5.0" X 5.4" X 1.0")
Frequency Band	N/A
System Architecture	May be implemented with approach 2
Interface/Sensor Input	Interfaces to normally-open and normally-closed contacts, and RS-232 output
Line/Tamper Protection	Proprietary line encryption; tamper protection built into the enclosures
Multiplexing Capabilities	Up to 2 sensor inputs per device
Range of Transmission	Depends on site requirements
Transmission/Polling Rate	Data rate; 9600 baud
Power Supply	12 VDC @ 0.25 A; no battery backup
Advantages	Provides proprietary data encryption Very versatile Appropriate for approach 2
Disadvantages	High cost per input Only 2 inputs per unit Limited multiplexing capabilities No battery backup power on unit

Scientific Technologies Inc. - 551X Spread Spectrum Modem

Method of Transmission	Spread spectrum radio frequency signals transceived in the 905–928 MHz and 2.4-2.478 GHz bands.
Brief Description of System	This system consists of a spread spectrum, RF modem. This system uses several frequencies across a broad band to enhance data security and reliability. It is used in pairs designed for RS-232/RS-485 data transmission. Two models, transparent and intelligent, are available. The transparent model is designed to automatically handle asynchronous data without any port setup. The intelligent model performs error checking and packetizing on data to ensure integrity. The modems may also be used as repeaters to increase total transmission distance for the communication link.
System Components (Size)	Model-5510: 900 MHz transparent-transceiver (1.52 x 4.17 x 5.0") Model-5512: 2.4 GHz transparent-transceiver (1.52 x 4.17 x 5.0")
Frequency Band	905–928 MHz and 2.4–2.478 GHz spread spectrum bands
System Architecture	May be implemented with approach 2
Interface/Sensor Input	RS-232 data port
Line/Tamper Protection	None
Multiplexing Capabilities	The modems may be used in a "broadcast" mode; however, some software control, such as a polling scheme, would be required to avoid interference. The units may be used on one of up to 19 to 37 channels depending on which model is selected.
Range of Transmission	Indoor: 800–1500 ft; Nominal: 800 ft Outdoor: 1–1.5 mi.; clear line-of-sight
Transmission/Polling Rate	N/A. (Data: 1.2-19.2 Kbaud/asynchronous, 16-128 Kbaud/synchronous.)
Power Supply	Transmitter/Receiver - 12 VDC; no external power supply
Advantages	Reliable and secure method of spread spectrum technology Range of up to 1.5 miles Separate subchannels allows multiple units in the same range High-frequency carrier
Disadvantages	Very high cost No significant line protection or data encryption No tamper protection No battery backup on unit

United Marine - Intelligent Encryption Module

Method of Transmission	Three conductor bi-directional communication loop.
Brief Description of System	The IEM3000 intelligent encryption module is a microprocessor-based communication interface to encrypt, decrypt, and process status changes from standard detection devices. The IEM3000 has input channels for normally-open and normally-closed alarm contacts along with an output channel to allow control of optimal self-test within the detection device.
System Components (Size)	IEM3000 encryption module (5.2" X 1.4" X 0.6")
Frequency Band	N/A
System Architecture	Approach 2
Interface/Sensor Input	Interfaces to normally-open and normally-closed contacts
Line/Tamper Protection	Proprietary line encryption; tamper protection built into the enclosures
Multiplexing Capabilities	None
Range of Transmission	Up to 2000 feet
Transmission/Polling Rate	N/A
Power Supply	7-16 VDC @ 100 mA; no battery backup
Advantages	Provides proprietary data encryption Very versatile Appropriate for approach 2
Disadvantages	High cost per input No multiplexing capabilities No battery backup on unit

Wireless Video Communication Systems

This section provides information on wireless transmission systems encountered while performing this market survey. Unfortunately, a feasible and cost-effective system that incorporated both wireless alarm status and video transmission could not be identified. We found out that Charles Ringler and Chris Hoover of Department 5849 were already performing a related, more extensive market survey on wireless video transmission and video authentication. We decided that instead of allocating resources on a similar survey, we would instead refer to this more comprehensive study. This document is scheduled to be released by June, 1995. The systems below are from potential manufacturers that will be reviewed in the Wireless Video Transmission and Video Authentication Survey.

Wireless Video Communication Systems

Method of Transmission

Several transmission methods exist, but spread spectrum and UHF are the most prominent method of video transmission.

Brief Description of a Typical System

Most systems consist of a transmitter/receiver pair. Some systems offer repeaters to extend the transmission distance. They use a wide variety of transmission methods, but spread spectrum is probably the most reliable and secure method of video transmission. The systems below are commercially available for wireless video transmission.

Systems

Wireless Technology Inc. – FS-925 Fixed Video Transmission System
Wireless Technology Inc. – FS-935 Fixed Video Transmission System
Wireless Technology Inc. – PS-991 Portable Video Transmission System
Fiber & Wireless – WVL-90 Wireless FM Video System
Micro Tex – MiniLink Wireless Video Transmission System
Universal Security – V_9900 Wireless Video Transmission System
Watec – WAT-510 Wireless Transmission System
Pelco – WLV500KT Wireless Video Link
Pelco – WLV1000KT Wireless Video Link
SNL – Image Transmission System
VICON – Air Link Wireless Video Transmission System
Covert Security – Wireless Video Transmission System
Clear Data – A900 Wireless Video System

Advantages

N/A

Disadvantages

N/A

Comparison Table #1

This comparison table provides a quick reference for the system costs, advantages, and disadvantages for the wireless RF communication systems.

Manufacturer/System	Cost of Components	Advantages	Disadvantages
Inovonics-MCR16/C200 System	Transmitter - $34 Receiver - $390 Programmer - $116	• Relative low cost per channel • Supports n-o, n-c, and RS-232 format • Good range and repeaters also available • High-frequency carrier • Programmable report period • Multiplexes up to 16 transmitters per receiver	• No line protection or data encryption • No external or backup power on transmitter
Northern Computers-SpreadCOM System	Transmitter - $99 Receiver - $645	• Spread-spectrum is more secure • Good range • High-frequency carrier • Multiplexes up to 64 transmitters per panel	• High cost • No line protection or data encryption • Only n-c circuits supported • Reporting periods not programmable
ADEMCO - Wireless Alarm System	Transmitter - $41 Receiver - $120 Control Panel - $140	• Low cost • Multiplexes up to 16 transmitters per receiver	• No line protection or data encryption • Limited range • Single frequency operation • Low-frequency carrier • Reporting periods not programmable • No external or backup power on transmitter
Linear - Single-Channel System	Transmitter - $27 Receiver - $43	• Very low cost	• No line protection or data encryption • Limited range • Single frequency operation • Low-frequency carrier • Status reporting must be externally activated • No external or backup power on transmitter
Linear - Multiple-Channel System	Transmitter - $27 Receiver - $76	• Low cost • Multiple channels	• No line protection or data encryption • Limited range • Low-frequency carrier • Status reporting must be externally activated • No external or backup power on transmitter
Linear - Supervised Wireless System	Transmitter - $27 Receiver - $100	• Low cost • Multiple up to 32 transmitters per receiver	• No line protection or data encryption • Limited range • Low-frequency carrier • Status reporting must be externally activated • No external or backup power on transmitter
Linear - Midrange System	Transmitter - $118 Receiver - $1137	• Good range • Low cost • VAC power supply w/ battery backup	• High cost • No line protection or data encryption • Low-frequency carrier • Status reporting must be externally activated
NAPCO - Magnum Alert Wireless System	Transmitter - $79 Receiver - $189	• Low cost • Good range • Multiplexes up to 16 transmitters per receiver	• No line protection or data encryption • Low-frequency carrier • Reporting periods not programmable • No external or backup power on transmitter
Visionic - SpiderAlert Wireless System	Transmitter - $29 Receiver - $27 Multiplexer - $50	• Low cost • Repeaters available	• No line protection or data encryption • Limited number of transmitters • Low-frequency carrier • Status reporting must be externally activated • No external or backup power on transmitter
ITI - SX5 Wireless Alarm System	Transmitter - $26 Receiver - $294	• Low cost • Adequate range • Multiplexes up to 61 transmitters per receiver	• No line protection or data encryption • Single frequency operation • Low-frequency carrier • Reporting periods not programmable • No external or backup power on transmitter
CRN Radio Alarm System	Transmitter 1-$205 Transmitter 2-$229 Receiver - $695	• Provides proprietary line supervision • Supports voltage, contact closures, and TTL • Good range and repeaters also available • High-frequency carrier	• Very high cost • Reporting periods too long • Low-frequency carrier
Seaboard RC-2 Wireless System	Transmitter - $449 Receiver - $2695	• Provides proprietary line supervision • Excellent range and repeaters available • Multiplexes up to 243 transmitters per receiver	• Very high cost • Status reporting must be externally activated • Low-frequency carrier
SNL - UNIMod System	Transmitter ≈ $500 Receiver ≈ $500	• Relatively low cost for features provided • Provides DES line protection • Supports n-o, n-c, and RS-485 format • Excellent range and repeaters also available • Programmable report period • Multiplexes up to 2000 transmitters per receiver	• No tamper protection on transmitter/receiver • Low-frequency carrier • No external or backup power on unit
SNL - AIMS	Transmitter - $150 Receiver - $300 Processing Unit - $5000	• Provides proprietary line authentication • Supports n-o, n-c, and RS-232 format • Good range • Multiplexes up to 2048 transmitters per receiver	• Relatively high cost • No external power supply on transmitters
SNL - WATCH System	Transmitter - $39 Receiver - $390	• Low cost • Supports n-o, n-c, and RS-232 format • Good range • High-frequency carrier • Programmable report period • Multiplexes up to 16 transmitters per receiver	• No line protection or data encryption • No external or backup power on transmitter
Intellitech - Lookout Dispatcher	System - $2500	• Good range and repeaters are available • Multiplexes up to 12 transmitters per receiver • VAC power supply with battery backup • Programmable reporting period	• Very high cost • No line protection or data encryption • Low-frequency carrier • No external or backup power on transmitter

Comparison Table #2

This comparison table provides a quick reference for the system costs, advantages, and disadvantages of fiber optic, hardwire, and other communication systems.

Manufacturer/System	Cost of Components	Advantages	Disadvantages
Math Associates - Fiberoptics Control Module	Transmitter - $300 Receiver - $320	• Relatively low cost • Available in analog current loop • Battery backup available	• Cost does not include the cost of the fiber • No line supervision or tamper protection
American Fiber - Fiberoptic Status Control Modules	Module/pair - $800	• Relatively low cost per channel • Good transmission distances	• Cost does not include the cost of the fiber • No line supervision • No tamper protection
Fibronics International - Fiber-optic Modems	Modem pair 1-$580 Modem pair 2-$980	• Relatively small size • Requires no power supply	• Very high cost per channel • No line supervision or data encryption • No tamper protection
Puleo Electronics - Alarm Encoder/Decoder	System - $3960	• Encodes/decodes up to 48 discrete alarms • Near Instantaneous alarm reporting • Communications link loss detection • Good range	• Very high cost • No tamper protection • No battery backup on unit
Litton Poly Science - Intelligent Transceiver	Transmitter - N/A Receiver - N/A	• Built-in line supervision and tampering	• Relatively high cost • No multiplexing capabilities
Dantel - Multiple Transmitter Module	Transmitter - $398 Receiver - $495	• Loss of communication link detection • Good transmission distances • Reproduces 32/closures in a twisted pair • Near Instantaneous alarm reporting	• High cost • No line protection or data encryption • No tamper protection • No battery backup on unit
Cyplex - PowerPlex Communication Module	System ≈ $200	• Low cost per input • Small compact design	• System may require an AMCS interface • Design effort has not been fully investigated
Stellar - Remote Control Transponder	System ≈ $829	• Partial line supervision • Multiplexes up to 256 transmitters per receiver • Very versatile	• High cost • Only 4 inputs per unit are supervised • No battery backup on unit
Stellar - EFS2 Encryption Module	Module ≈ $506 each A pair is required.	• Provides proprietary data encryption. • Very versatile • Appropriate for Approach 2	• High cost per input • Only 2 inputs per unit • Limited multiplexing capabilities • No battery backup on unit
Scientific Technologies - 551X Modem	Transmitter - $1790 Receiver - $2390	• Spread spectrum technology • Good range • High-frequency carrier	• Very high cost • No significant line protection • No tamper protection • No battery backup on unit
United Marine - Intelligent Encryption Module	System ≈ $695	• Provides proprietary data encryption • Very versatile • Appropriate for Approach 2.	• High cost per input • No multiplexing capabilities • No battery backup on unit

Conclusions

The communication systems described in this document are all commercially available and vary considerably in terms of cost, features, and capabilities. Only a few systems were found to be useful because a significant percentage did not provide an interface directly compatible with the existing alarm system. Those systems that appeared to be applicable usually did not provide adequate data encryption, alarm supervision, transmission range, or battery backup. While such features could be incorporated using additional hardware, doing so would make the system more expensive and conflict with the idea of purchasing a single unit that meets the minimum set of requirements. Also, several of the systems greatly exceed the scope of this project; utilizing such systems would mean investing in more capacity than is really needed.

Recommendations

Three possible system approaches were explored, and the results were described in this document. Each approach took into account the level of line security relative to cost. Approach 1 was the least secure but the least expensive of all systems. Approach 3 was the most secure but also the most expensive. Line protection should be addressed in terms of risk assessment relative to the security level of the asset being protected. Thus, it is recommended that all three approaches be evaluated to accurately assess their capabilities, fully understand equipment installation, and the cost necessary for each level of security protection. All of the systems evaluated fall into one of the three system approaches. At least one system from each category should be purchased for further investigation.

The systems should be installed at Sandia and should undergo an intensive evaluation to determine in more detail the strengths and weaknesses of each system. The acquisition of the following systems is recommended for an in-house evaluation.

Approach 1

- Inovonics – MCR16/C200 System
- Northern Computers – SpreadCOM System
- ADEMCO – Wireless Alarm System
- ITI – SX5 Wireless Alarm System
- Linear – Single-Channel System
- Linear – Multiple-Channel System
- Linear – Supervised Wireless System
- Linear – Midrange System
- NAPCO – Magnum Alert Wireless System
- Visionic – SpiderAlert Wireless System
- CRN – Radio Alarm System
- SNL – WATCH System
- SNL - Universal Network Interface Module

Approach 2

- Scientific Technologies – 551X Modem
- Stellar Systems – RDU-300 Transponder
- Stellar Systems – EFS2 Encryption Module

Approach 3 • SNL – Authenticated Item Monitoring System

The evaluation process will concentrate on installation, cost, security level, and line protection issues. It will also evaluate any interface requirements, interface compatibilities with the existing AMCS system, and any design requirements for black-box interfaces. The outcome of this evaluation will be a prioritized list of the systems that hold any promise. The list will consider the risk assessment and levels of protection relative to the level of line security required for the asset being protected.

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