LONG-RANGE MESH RADIO NETWORKS AND APPLICATIONS IN THE ALARM INDUSTRY

A Technology Overview

Presented by

LONG-RANGE MESH RADIO NETWORKS AND APPLICATIONS IN THE ALARM INDUSTRY

Table of Contents

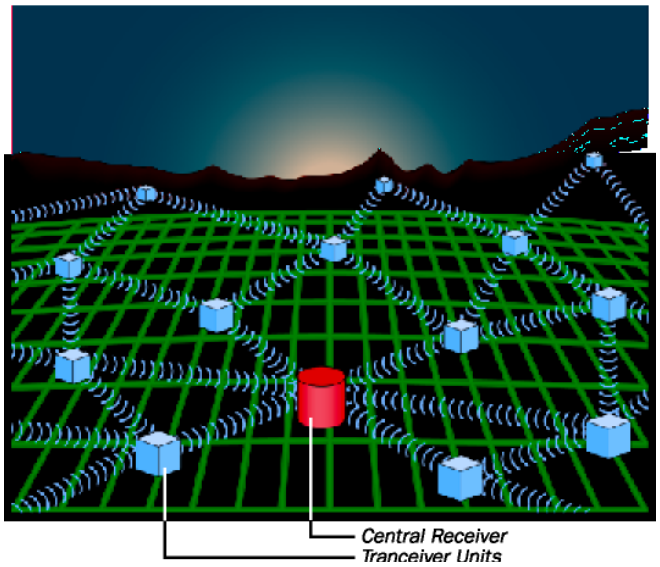
1.0 WHAT IS MESH RADIO NETWORKING?

Mesh radio networks are the newest innovation in wireless technology. Historically, all wireless networks suffered from the same limitations imposed on wired networks. The information path was limited to one single route back to a central data point. If that one route was unavailable, then the entire network was unusable. The network was entirely dependent upon every node on the network being active at all times. Given the vagaries of weather, technical problems, user error, or malfunctioning equipment, maintaining a single route wireless network was very difficult. Users of single route wireless networks found them complex to install, very difficult to maintain, subject to low transmission rates with unacceptable performance levels.

A mesh radio network overcomes these weaknesses by providing multiple paths for data transfer. Wireless mesh networks such as those using patented **AES-*IntelliNet*®** technology use two-way smart transceivers for communicating data between remote monitored locations and the Central Receiver. A Smart Subscriber Transceiver (SST) – an intelligent device that acts as a transmitter, receiver, repeater and router, links each remote site to the Central Receiver.

In a mesh network, every SST is capable of sending and receiving data from another SST or the Central Receiver and sending it to its final destination. Critical event data is transmitted directly to the central station if the SST is within radio range, if not it is relayed through one or more SSTs. Data always follows the shortest, most reliable route available.

The diagram below portrays distribution of remote units and data paths of an AES-*IntelliNet* network.



The Central Receiver is the primary receiving location of data for the network. The Central Receiver is a computer platform that integrates network management software and related applications to maximize network management. Each box indicates an SST in a remote location that sends and receives data from the Central Receiver and other SSTs to ensure a dynamic data path, which optimizes information flowing reliably across the network on a continual basis.

A. Redundancy - A Key Attribute of the Network

If data cannot be sent by one route, the intelligent SST automatically selects the next best route. Redundant routes ensure high reliability. From any given remote SST, there are many different routes the data can take. The dynamic process of polling the network to find the quickest, most reliable data path is a continual process. If any remote SST in the network is unable to store and forward the data, then the network immediately analyzes and selects an alternate route ensuring that the alarm communications get through to the Central Receiver. The network constantly self-adjusts communication routes to optimize the flow of information. This "smart routing" means the network is continually optimizing the pattern of alarm communications to ensure the quickest, most reliable path to the Central Receiver.

B. Distributed Networks Offer High Reliability

SSTs at remote locations dynamically adapt themselves to changes in the network, continually optimizing the system for best performance. Every message received is authenticated, acknowledged and forwarded. The two-way SSTs communicate constantly with the Central Receiver and other remote units to ensure connectivity. If a unit fails to check in, the Central Receiver alerts the system operator who can assess problems from the console utilizing the network management software. Wireless mesh technology is resistant to environmental disturbances and equipment problems that plague radio tower based solutions or other single route systems by continually optimizing multiple signal paths.

Mesh networking offers high reliability in data flow so that messages are received quickly and accurately. The redundant nature of the network ensures that messages always find a path to the Central Receiver.

Optimizing Network Connectivity

Mesh radio networks require no specialized knowledge of radio transmission. Tools such as Net/Con Measurements ease the installation and management of the network. The process of managing network connectivity for maximum reliability and redundancy in the wireless/radio industry is commonly referred to as Net/Con (**Net**work **Con**nectivity).

"**Net/Con**" is a rating of the "Network Connectivity" quality between multiple SSTs in remote locations and the Central Receiver in a wireless data network. Net/Con ratings range from 0 to 7, with 0 being the best connectivity rating. The rating is established by considering many factors including the following:

- Number of paths available
- Net/Con rating of other units in each path
- Link layer (number of subscriber unit hops to the central station)
- Signal strength
- Low battery conditions

A low (good) Net/Con rating, such as 0 is achieved if the remote SST is in direct communication with the Central Receiver. Net/Con ratings can be used to guarantee an SST has at least 2 valid paths available or is communicating directly with the Central Receiver.

A SST cannot have a better Net/Con than that of any member in its routing path. If a high (or poor) Net/Con rating is indicated for any SST, then steps can be taken by the network operator to improve the network quality.

The AES-*IntelliNet* private wireless mesh radio network is designed to dynamically update the SST data paths to the Central Receiver on a continuous basis. As SSTs are added or removed, the network automatically updates the data paths for optimum reliability. The Net/Con rating for each SST can be identified by using the network management software in the Central Receiver or by using the handheld programmer connected to the SST in the field.

C. Mesh Networks Yield Low Cost of Ownership

The two-way sending and receiving capability of every SST, dispersed over a geographical area, means that mesh networks can be managed remotely from the Central Receiver. This reduces the number of services calls that need to be made to remote locations. Adding additional SSTs expands and strengthens the network. As new units are added, the network dynamically reconfigures itself to incorporate the new unit, exploiting the new paths created by the added SST. This allows network expansion without upgrading system components or requiring any special radio expertise that alternative communication methods need. Mesh networks can grow to cover thousands of square miles through the addition of SSTs while traditional systems would require expensive expansion of physical plant and equipment in order to expand into larger territories or fill in gaps of coverage in existing territories.

2.0 PRIMARY COMPONENTS OF A LONG-RNAGE MESH RADIO NETWORK

A mesh radio network, typified in this example by an AES-*IntelliNet* network, is composed of two basic elements: the Central Monitoring Station (CMS) and the Smart Subscriber Unit (SST). The CMS is housed at a central location, monitors data sent by the SSTs and manages the overall network. The SSTs are installed at multiple remote sites.

These primary elements utilize common radio components that allow them to send and receive wireless data on a single radio frequency. The frequency is private and known only to the operator unlike cellular based systems where the frequencies are publicly known and subject to jamming. Elements include a 2-Watt radio transceiver (VHF or UHF) and a Communications Controller made up of a microprocessor and a modem. In the CSM, a Communications Controller is the interface between the radio transceiver and the integrated computer based software which interprets the data and manages the network. For example, in the SST a Communications Controller links the local alarm control panel and the radio transceiver.

Central Monitoring Station (CMS) – The CMS is the primary computer platform to which data from the SSTs is received and from which outgoing data is sent. It converts the data from the wireless format to the digital format, which then interfaces with the software and peripherals.

The CMS is the central hub of an AES-*IntelliNet* alarm communications network and provides the following:

- Receives all data messages from the radio network
- Acknowledges all data messages from the radio network
- Annunciates inbound alarms, systems faults & warning conditions
- Outputs system activity to a printer
- Manages the Network Controller and Network Management Software

Smart Subscriber Transceiver (SST) – Geographically dispersed at remote locations, the Smart Subscriber Transceiver is connected to the monitored device. If the SST is in geographic radio range (typically 1-5 miles and often much greater) then it communicates directly with the CMS. If not, the SST relays its message to another SST closer to the CMS. This second subscriber unit acts as a store-and-forward message repeater for other SSTs that are beyond direct radio reach of the central station. Each SST dynamically evaluates and stores information on all possible “routes” through which it can send messages to the CMS.

3.0 MESH RADIO TECHNOLOGY FOR THE ALARM INDUSTRY

A. Alarm Industry Communications Requirements

In the fire and security industry, there is a basic requirement to quickly and reliably transmit alarm data from remote alarm panels to a central monitoring station. This central monitoring station is located remotely from the alarm panel.

In addition to the requirement for quick and reliable alarm data transmission, the industry also prefers the following:

- **Transmission Speed** – Receive the alarm within a few seconds from incident occurrence.
- **Redundancy** – Provide multiple communications paths to ensure high reliability.
- **2-way communications** – Two-way communications assure that data is received and authenticated at every step. The transmitting device receives an acknowledgement for every data packet sent. One-way devices have no way of knowing that data has been received. The two-way feature also enables the user to remotely test and program the communications network.
- **Minimize recurring monthly costs** –- Minimize or eliminate monthly communications costs associated with traditional networks.
- **Installation and maintenance** – Establish new remote sites quickly without relying on other network operators and maintain geographically remote locations in a cost effective manner.
- **Compliance** – Network systems need to comply with local, state, and federal requirements for narrowband wireless networking, Central Station Alarm Association initiatives toward narrow banding of available radio frequency broadcast bands, UL listed and NFPA compliance requirements depending on the application.

Long-range mesh radio networking such as AES-*IntelliNet* offers unique advantages that serve the many needs of today's alarm industry.

B. Current Alternative Communication Methods

An overview of the current offerings for alarm industry communications highlights the strengths and weaknesses of current systems and illustrates why wireless mesh networking sets a new standard for meeting and exceeding industry communication requirements in reliability, speed, manageability and reduced cost of ownership.

- **Telephone Line** – Has the advantage of being available in most places but has a relatively high monthly recurring cost (if not a shared use line), installation may take weeks, and there is no redundant communications path even if two phone lines are engaged. Neither the end user nor the Central Station operator has any control over the network and telephone lines are subject to line cuts, weather, and equipment malfunction. With new laws enabling cell phone users to keep their telephone numbers even when they change carriers, many have disconnected their landline based home phones thereby cutting their traditional connection to the central alarm monitor.

- **Direct Wire** – An antiquated technology provided by telephone companies, Direct Wire circuits connect a premise to a monitoring station utilizing a supervising current. Direct Wire has limited availability, is expensive by comparison, and provides little critical event information.

- **Derived Channel** – Derived Channel circuits were prevalent in major market centers and established between the protected premise and Telco Central office by use of a poll-response protocol and sub-audible tone on POTS circuits. The telephone companies are currently eliminating Derived Channel offerings due to low customer volumes and technological incompatibilities with multiplexing technologies used today in the ordinary routing of phone calls.

- **Cellular** – Installation can be done in one day as opposed to standard telephone lines, but this option still has a high monthly recurring cost and network coverage is far from everywhere, particularly in rural areas. Transmission times can be lengthy as the call traffic is routed through multiple centers prior to arriving at the monitoring sites. Cellular frequencies are publicly known, meaning jamming devices may be purchased to interfere with signals. Operators have no control over the transmission network.

- **Satellite** – Network coverage is pretty much everywhere including rural areas. It has a very high monthly cost and the equipment can be quite

costly, therefore there is very little implementation in the fire and life safety industry.

- **Private Tower-Based Radio** – There is a high upfront investment in the receiving equipment at the monitoring site. In network installations, this can typically be done in one day. However, repeater tower space is very expensive as rental fees have escalated dramatically in recent years. Single point transmission sites utilizing "line of site radio transmission" may require complex antenna installations at the subscriber site and create ongoing service issues. Directional antennas are often required. Extending geographic network coverage requires significant capital and operating expenses from the licensee as well as a high level of radio and engineering expertise. One-way radio transmission offers no supervision from the operating centers to dispersed network devices. While two-way private radio towers offer the ability to interrogate network devices, the systems still suffer from the same limitations.

- **Long-Range Mesh Radio Networks** – Currently offer the most comprehensive offering for the alarm industry by overcoming many of the drawbacks associated with alternative offerings.

The upfront investment in establishing a private wireless mesh network is relatively small compared to traditional alarm communication systems. A typical field installation can be done in one day and is not dependent on public third party service providers such as telephone companies. There are no recurring monthly costs such as those associated with phone or cellular time or leasing radio tower space since a mesh radio network provides its own communication medium. The network provides high levels of redundancy and reliability at low operational costs. As additional subscribers are brought on line, the network naturally expands. Every additional remote site expands the network allowing signals to be "smartly routed" to the receiving center via the most efficient path. As the network grows, it becomes more redundant and reliable. The operator is also the owner and maintains complete control over the network, just as they have control over their installation and monitoring services.

C. Primary Users of Long-Range Mesh Radio Networks in the Alarm Industry

Today AES-*IntelliNet* based alarm monitoring communications systems are used at hundreds of thousands of locations in more than 85 countries. Two of the primary applications are discussed below.

- **Central Monitoring Alarm Dealer** – Alarm dealers typically provide 24/7 monitoring services to residential and commercial user's intrusion and fire alarms. The alarm dealers typically utilized telephone company wire-line, cellular or private radio communications services to monitor customer's alarms at the dealer's central station. However, as highlighted earlier, these communications solutions became burdensome for dealers and their customers for reasons of high monthly recurring costs, slow availability, and inconsistent reliability. In other cases, regulations for fire monitoring required using telephone company services that have become increasingly less available and more expensive.

  In migrating to AES-*IntelliNet* based solutions, the alarm dealer is able to deploy service immediately (critical for getting a Certificate of Occupancy for new buildings), less expensively (since the dealer is now able to offer a lower cost communications network to customers) and more profitably (since the dealer can now offer a communications service in conjunction with their monitoring service which significantly increases revenue from an existing customer base).

- **Proprietary Users** – Proprietary users are entities such as municipalities, large corporations, military bases and universities, which have a fixed number of alarms to monitor in their network of buildings. Rather than contract with an alarm dealer (above), they monitor these themselves. These customer groups are motivated by the need to reduce their operating budgets by eliminating monthly communications charges along with reducing installation, operation, and maintenance costs. They are also motivated by avoiding the costs of digging and trenching required by wired solutions.

A Summary Chart
of selected applications and their technical, regulatory, and business requirements
is listed below

	Technical Needs	Regulatory Needs	Business Needs
Alarm Dealers	- Reliability - Redundancy - Network mgmt	- UL 1610, 827, 864 Listed - NFPA72 Fire Compliant	- Reduce costs - Maximize RMR
Military Bases	- No wiring problems - No dial tone needed - Supervise radios - 2-way data on 1 freq.	- NFPA72 Fire Compliant - Narrowband Compliant - HERO certified	- Cheaper method - GSA Listed - No recurring telco costs
Universities	- No wiring problems - No dial tone needed - Supervise radios - Transmission summary - Receive premise info - Transceiver as repeater - 2-way data on 1 freq.	- UL 864 Listing - NFPA72 Fire Compliant	- Cheaper method - Reduce dept. budget - Reduce inter-dept. issues - No recurring Telco costs
Corporate Campuses	- No wiring problems - No dial tone needed - Uniquely identify bldgs. - Addressable info avail. - Opening/closing reports - 2-way data on 1 freq.	- UL 864 Listed - NFPA72 Fire Compliant	- Cheaper method - Reduce dept. budget - Reduce inter-dept. issues - No recurring Telco costs
Municipalities	- Transceivers interfaced by zone input for DPW - Water towers preferred repeater sites - No wiring problems - No dial tone needed - For fire, intrusion and municipal signaling too	- UL 864 & 1610 Listed - NFPA72 Fire Compliant	- Generate new revenue - Offset expenses - High reliability communication needs - Reduce maintenance costs and requirements - Offer additional services to community

D. Specific Products and Applications

A Profile Chart
of the most commonly used AES Transceivers is listed below

AES-*INTELLINET* SUBSCRIBER TRANSCEIVER PRODUCTS

	7788F Series	**7058E Series**
Primary Application	Commercial Fire	Burglary/Security
UL Listed	UL 864 – Ed.9	UL 2017
Radio Frequency Bands	146-174 MHz, 500-512 MHz	146-174 MHz, 500-512 MHz
RF Power (watts)	2-5 Watts	2-5 w
Full Burglary Data	W/IntelliPro Fire 7794	W/IntelliPro 7094
Full Fire Data	W/IntelliPro Fire 7794	N/A
Programmable Zone Configurations	8	8
Line Fault Monitor	Included	W/IntelliPro 7094
Battery Backup	7aH	7aH
Transformer Primary Power	16.5/40 VA	16.5/40 VA

4.0 CONCLUSION

Long-range mesh radio networks is an innovative technology that is rapidly being adopted by many industries with applications that need to communicate small amounts of data over a large geographic area with a high level of reliability at a low cost of ownership. The advanced design and two-way communications capability of mesh radio networks provide easy installation, expansion, and management when compared to traditional communication methods, both wired and wireless.

One industry that has embraced the new technology is the fire and burglary alarm industry. For this group, redundant communication paths ensure high reliability. The speed of the network in delivering critical information and its low cost of ownership combine to make long-range mesh radio networks a superior offering when compared to alternative communication methods.

AES-*IntelliNet* is the industry leader in delivering high quality mesh radio networks to the fire and burglary industry in commercial, municipal and educational applications with its broad line of products and advanced network management tools. Users of AES-*IntelliNet* networks have gained significant revenue, communications and cost advantages while continuing to meet the high standards of reliability required for the fire and security industry.

CONTACT

Sales
(800) 237-6387 or (978) 535-7310 main | (978) 535-7313 fax
sales@aes-intellinet.com

Technical Support
(800) 237-6387, Option 4 or (978) 535-7310, Option 4
support@aes-intellinet.com