



## **White Paper**

ViaLogy SPM™ Framework:  
Realize the Vision of Scalable,  
Intelligent IP-based Sensor Networks



**VIALOGY®**



# ViaLogy SPM™ Framework: Realize the Vision of Scalable, Intelligent IP-based Sensor Networks

## Executive Summary

Businesses and government agencies depend on different types of sensors—video surveillance cameras, temperature, pressure, acoustic, chemical, and others—to gain early awareness of events that can adversely affect enterprise operations, security, and business continuity. However, frequent false positives drain resources, and false negatives can lull operational staff into incorrectly believing that no problems are brewing.

Systems integrators have attempted to reduce the incidence of false positives and negatives by fusing the input from multiple types of sensors to provide actionable information to end users. However, until now the sensor integration process has been inherently time-consuming, costly, and difficult to replicate. In addition, loss of coverage occurs whenever the system needs routine maintenance or a new sensor is added.

This white paper, intended for systems integrators as well as enterprise operations managers in the public and private sectors, explains ViaLogy's network-centric approach for enabling truly smart sensor networks. Unlike sensor-management solutions that only work with sensors from certain suppliers, the ViaLogy SPM™ software and hardware solution can automatically discover network-attached sensors from any vendor, fuse and normalize their inputs for distributed, Web-based monitoring, and invoke real-time responses based on customer-defined policies. The network-centric approach provides measurable benefits for security, safety, and surveillance. Uniquely, ViaLogy SPM™ software is highly scalable, automatically integrating up to thousands of sensors connected to wireless and wired Internet Protocol (IP) networks without delays or loss of coverage.

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## Limitations of Today's Sensor Management Approaches

Today, the various types of sensors that an organization uses—cameras, lasers, radar, acoustics, and others—are independently managed and monitored, usually by human

operators. The inability to automatically fuse outputs from different types of sensors makes it difficult to accurately detect and report events that require prompt response. False negatives, such as when a fatigued operator fails to notice a significant event on a video surveillance feed, can be catastrophic. Conversely, false positives force the operator to constantly check to see if incident alerts are actually serious threats. An operator who relies on acoustic sensors to monitor perimeter security, for example, must conduct an in-person investigation to determine if a detected interloper is a human or an animal. Table 1 summarizes the disadvantages of managing discrete, non-networked sensors.

**Table 1.** Problems with Managing Discrete, Non-Networked Sensors

<i>Problem</i>	<i>Example</i>
False positives	Perimeter security motion sensor was tripped by an animal.
False negatives	Human fails to notice out-of-range sensor reading or significant event captured by video surveillance camera.
Delayed awareness and response to critical events	Oil field operations personnel are not alerted to incipient leaks revealed by slightly off-normal readings from different types of sensors.
Underutilization of sensors because of their placement	No historical trending information is available to help determine if a sensor would be more useful in another location.
Information available at one terminal only	Operational personnel can only view sensor readings from a dedicated terminal or from the sensor itself. This prevents “follow-the-sun” monitoring by personnel in different geographical locations, and also impedes continuity of operations if employees cannot access the sensor or terminal for any reason.
Lack of automated response	Until now, there has been no easy way to rapidly and reliably implement policy-based response to sensor input, such as triggering another sensor for a confirmatory test, locking doors, or notifying a response team.
Limited value from RFID sensors	RFID sensors indicate that an asset has moved, but not who moved it.

System integrators can integrate the input from multiple sensors to overcome these challenges. However, the process has historically been time consuming and costly. Whenever an organization adds or removes a new sensor, the systems integrator has to modify the back-end software, business logic, and the user interface or dashboard. Temporary loss of coverage occurs when new sensors are added. Costs increase exponentially as the organization attempts to integrate more and different types of sensors, especially highly complex sensors such as radars and chemical, biological, radiation,

nuclear and explosives (CBRNE) sensors. Furthermore, it is difficult to transition from centralized to distributed control as the network grows.

## Criteria for an Effective Sensor-Network Management Solution

Following are the criteria for a truly effective sensor network management solution—one that provides actionable information and accelerates response based on sensor input. While existing solutions meet some of these criteria, no solution until now has successfully met all of them.

- *Tracks and fuses input from multiple sensors autonomously.* Intelligent sensor fusion reduces false positives and negatives, and produces more reliable information for the operator.
- *Provides sensor interoperability.* Organizations need the flexibility to integrate input from any sensor connected to the network: legacy sensors as well as new sensors based on different interfaces and protocols.
- *Automates responses based on customer-implemented policies.* Policies can be simple, such as flashing a red light on an operator console, or very complex, such as triggering other sensors to confirm the input and then taking a variety of actions based on the outputs of additional sensors and policies.
- *Performs signal processing to extract weak signals of interest from background clutter.* This is a tactical challenge in many sensor deployments, and can result in incipient problems going undetected.
- *Scales.* Many organizations need the capacity to support hundreds, thousands, or tens of thousands of sensors of different types, either regionally or globally.
- *Is network-centric:* Organizations should be able to control and monitor sensors from any Web browser in any location. Globally distributed monitoring enables follow-the-sun support and also supports business continuity if employees are not able to work from a particular location.

### Organizations Experiencing High ROI from the ViaLogy SPM™ Solution

- Gas and oil exploration firms
- Companies using building management systems
- Federal government, including Department of Defense and Department of Homeland Security
- Manufacturers and retailers that need to protect physical assets from theft.

## Solution: The ViaLogy Sensor Policy Manager

The ViaLogy SPM™ solution is a complete software and hardware policy framework that system integrators can use to create smart, IP-based sensor networks. Using an intuitive, graphical user interface, the system integrator can define policies that fuse the inputs from

networked sensors, identify events of interest, and automatically invoke actions based on different combinations of inputs from sensors and other policies. After the system integrator deploys the solution, the organization's operations team can use the intuitive interface to modify policies in real-time, as the environment changes.

ViaLogy SPM™ software is designed to work with any type of sensor and network architecture. It is highly scalable, integrating up to thousands of sensors attached to wired and wireless IP networks, including:

- Homeland security systems: CBRNE sensors and border protection systems
- Enterprise surveillance and security: Video surveillance and CCTV, alarm systems, access-control, and tracking
- Infrastructure protection: Smart fencing and intrusion detection
- Building systems: HVAC, lighting controls, environmental controls, chemical, biological, and radiation sensors

### Application Scenario: Video Surveillance

*Before:* A team of security personnel monitors several video streams from surveillance cameras, looking for general events such as a suspicious vehicle or package left unattended, as well as specific events such as the presence of a red vehicle of a certain make. A single operator is often responsible for monitoring multiple screens. No matter how well-trained and vigilant, the employee can easily overlook significant events because of the "needle-in-the-haystack" problem—that is, sparse events of interest remain buried within a large volume of uneventful video frames. Staffing and training costs for highly trained personnel are high.

*After:* The organization deploys the ViaLogy SPM™ software and hardware solution in conjunction with embedded video analytics software on ViaLogy's MicroSPM™ Gigabit-Ethernet video analytics boards. The video analytics software performs image processing on each video camera feed so that the administrator can precisely specify the events to look for, such as motion, lack of motion, a red Rolls Royce, or any vehicle present for more than a specified time. When one of these events occurs, ViaLogy SPM™ automatically initiates an action that the administrator defined in the policy (see sidebar). For example, the administrator might set up a policy stipulating that if the video analytics software detects someone carrying a suspicious package, ViaLogy SPM™ will initiate actions to collect input from chemical sensors in the vicinity to determine if the package contains explosive traces. Positive confirmation can trigger other pre-defined

#### Examples of Policy-Based Actions Triggered by Sensor Input

- Paging or calling a response team
- Sending an image or video stream to a response team
- Flashing a light, closing doors, and so on
- Triggering other sensors or policies to gather more input about the event to determine if it is significant
- Gathering historical trending data of the event of interest
- Tracking activities of identified targets of interest within a geospatial context

actions, such as immediately alerting nearby security crews, sending a photo of the suspect if the chemical traces are positive, and archiving the video if needed for later examination.

Using the ViaLogy SPM™ solution for video surveillance applications reduces false negatives and false positives, accelerates awareness of significant events, and reduces staffing requirements. No longer are large teams of operators needed to monitor a roomful of video feeds around the clock. Instead, ViaLogy SPM™ software can monitor all outputs from the video-analytics software much more reliably than a human could, and immediately notify first responders when designated events occur.

### **Application Scenario: Incipient Leak Monitoring in Oil and Gas Fields**

*Before:* If a pressure, temperature, or strain sensor suggests an incipient leak is present, a field operator might need to inspect hundreds of miles of pipeline to determine the leak location. Drawbacks include risk of injury for the operator as well as the high costs of responding to false positives.

*After:* The administrator uses ViaLogy's SPM™ to seamlessly fuse inputs from pressure, heat, strain, and acoustic sensors. The combination of inputs enables earlier and more accurate detection of incipient leaks. For example, when sensor readings are only slightly out of range—but for all three sensors—the likelihood of an incipient leak is quite high. The associated policy might be to notify the plant or rig supervisor, shut valves, and shut down processing operations. If only one reading is out of range, then a less severe policy might be invoked.

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Using ViaLogy SPM™ for incipient leak detection enables earlier detection, reduces time spent investigating false positives, and helps protect operators from potentially unsafe conditions. In addition, it significantly enhances the value of the organization's existing network of sensors.

### **Application Scenario: Physical Asset Protection**

*Before:* Insider theft is a common problem for organizations with mobile inventory or product. In many cases, a security guard performs visual inspections of purses and briefcases when employees exit secured areas. Some organizations deploy RFID readers to read asset tags. Both types of inspection are easily defeated, however, and many thefts go undetected.

*After:* The ViaLogy SPM™ solution can intelligently fuse inputs from different types of sensors to detect thefts. Suppose a manufacturing company uses video surveillance cameras on the factory floor and RFID sensors to track asset movement. The manufacturer can set up a policy that defines the actions taken when an RFID sensor is triggered—for example, cue a

video surveillance camera to take a picture of the person retrieving the asset, and then send it to the guard if the asset is not subsequently inventoried by the system. The guard can then be on the lookout for the individual in the picture and perform a more thorough search.

### Application Scenario: Border Security

*Before:* Effective detection and interdiction of border incursions is thwarted by false negatives and false positives. When notification is received at 2:00 a.m. that an unattended acoustic sensor was tripped, a border patrol agent generally has to drive out to the scene to determine if the interloper is a person or animal—an inefficient use of expensive resources. What is more, by the time the agent arrives on the scene, it might be too late to apprehend the suspect.

*After:* The border security agency can use ViaLogy SPM™ software to integrate the outputs from multiple sensor types to create a complete operational picture within the geographic region of interest. For example, ViaLogy SPM™ can fuse output from acoustic and radar sensors and infrared imagers to precisely identify the source triggering the event. The policy might state that if either an acoustic or radar sensor is tripped, ViaLogy SPM™ should send a command to the surveillance camera to pan towards the location and begin streaming video to the agent. An agent who sees that an animal tripped the sensor eliminates the need for someone to drive to the site. Conversely, if the video reveals several humans, the agent knows that sending a team rather than an individual is a wise use of resources. When developing a policy that includes sending alerts based on video input, the organization can choose to send either raw images or text-based messages generated by the video-analytics software, such as “Three people are crossing the border at coordinates x and y.” The option to transmit the text-based interpretation relieves operators of the need to analyze several thousand video frames to detect sparse events, and therefore can enable them to take action more quickly. Sending text messages also significantly reduces network bandwidth usage.

## How ViaLogy SPM™ Works



ViaLogy SPM™ is an IP network-centric software and hardware framework that uses a customizable policy engine to integrate networked sensors and make them interoperable. A policy associates conditions, which can include sensor input as well as other policies, with customer-defined actions. The ViaLogy SPM™ solution includes server software and a graphical user interface for use by the operational staff (Figure 1).

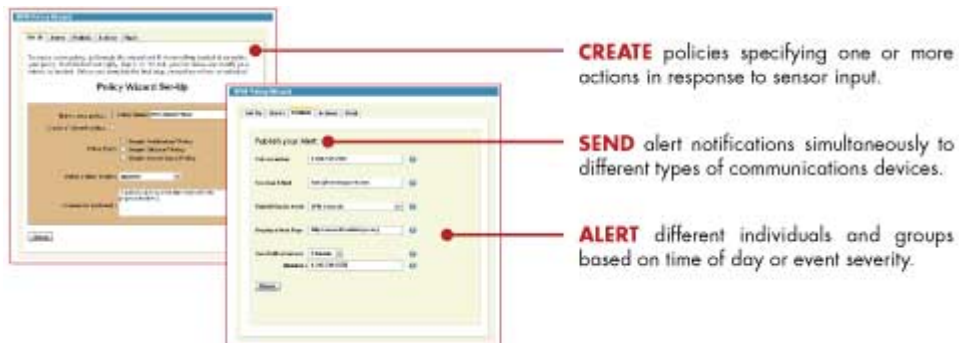
Figure 1: ViaLogy SPM™ GUI, With Fused Sensor Inputs and Actions

ViaLog SPM™ Solution components include:

- *Third-party sensors based on a wide variety of protocols.* The ViaLog SPM™ solution makes the sensors interoperable over IP networks.
- *Sensor adapters.* System integrators can connect existing sensors and cameras through ViaLog SPM™ sensor adapters, which are APIs for each sensor type. The adapters normalize the various sensor outputs so that the policy engine can interpret them and take the associated action. Sensor adapters can incorporate ViaLog's trademarked QRI™ signal-processing technology for extracting weak signals in noisy or cluttered environments (see sidebar).
- *Policy engine.* Systems integrators—and their customers, in some cases—use a graphical Policy Builder tool to specify actions to be taken when certain conditions are met. Figure 2 shows the screen used to associate conditions with actions.

**Solution to a Practical Problem:  
Weak Signals**

Quantum Resonance Interferometry (QRI™), ViaLog's breakthrough signal-processing algorithm, reliably detects and discriminates barely discernible signals that are up to 1,000 times quieter than the surrounding background noise. In addition to enhancing signals, QRI resolves traditional challenges associated with video, telephony, and control sensor integration and information overload.



**Figure 2** Associating Conditions with Actions using the Policy Builder Tool

**Deployment Options**

The ViaLog SPM™ solution can be deployed in a centralized, standalone configuration or in a distributed environment. In centralized environments, the ViaLog SPM™ software is usually deployed on a server (Figure 3).



**Figure 3** Various Platforms for Deploying ViaLog SPM™

Organizations with branch offices, remote locations, or mobile command vehicles can deploy a version of the ViaLog SPM™ software called ViaLog SPM™ Edge on servers, laptops, or in-vehicle Cisco Mobile Access Routers. Support for Windows Mobile 6 phones is planned. If a motion detector fires in the desert, for example, the local ViaLog SPM™ Edge server can invoke local policies and also send an alert to the central ViaLog SPM server in another location, which might then take other actions based on the input. Organizations can configure their edge systems through either a central or distributed ViaLog SPM™ environments.

### **Operational Benefits Summary**

ViaLog SPM™ provides the following operational benefits:

- *Faster response to threats.* The ViaLog SPM™ policy engine automatically invokes the actions specified in the policy, including disseminating information to appropriate people.
- *Automated detection and response workflow.* Rather than relying on a human to notice a significant event and take the appropriate action, ViaLog SPM™ software automates the process, accelerating response and reducing human errors as well as staffing and training costs.
- *Improved operations efficiency, and fewer false positives and negatives.* By fusing inputs from multiple sensors, ViaLog SPM™ solution provides reliable, actionable information. Automated, policy-based actions ensure that the right person receives the right information, at the right time.
- *Lower total cost of operations.* Factors contributing to lower cost of ownership include: fewer human operators needed to monitor and control hundreds or thousands of sensors; re-use of existing sensor infrastructure; standards compliance; fewer systems to purchase and maintain; and fewer costly mistakes.

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- *Management from any Web browser.* Authorized operations personnel can monitor and manage sensors in any worldwide location with network access.
- *Highly distributed command and control.* Any branch office or location can assume control of the ViaLogy SPM™ management interface. This helps ensure business continuity if disaster or adverse weather prevents operations personnel from working in a particular facility.
- *Easy integration of legacy sensors.* Organizations can continue to use their existing sensors as part of the smart sensor network. Integrating them with the ViaLogy SPM™ solution simply requires connecting them to an IP network, either directly or through an appropriate Ethernet gateway, and developing a sensor adapter.
- *Support for new sensor technologies as they become available.* ViaLogy SPM™ solution is both forward- and backward-compatible because it works with any type of sensor, from any vendor. It supports new advanced bio-threat sensors, which can confirm infections in minutes instead of days, and can scale to support thousands or millions of IP-based microsensors and nanotechnology-based sensors when they become available.
- *Investment protection and standards compliance.* ViaLogy SPM™ extends the life of the investment through the use of open standards and is compatible with both IPv6 and IPv4 addressing. ViaLogy SPM™ is certified by the National Incident Management System (NIMS) as compliant with the Organization for the Advancement of Structured Information Standards (OASIS) Common Alerting Protocol (CAP) 1.1 standard

## Conclusion

Many organizations have already invested in and deployed the sensors they need to protect their business or perform their mission. What has been lacking until now is a rapid, cost-effective way to integrate sensors from multiple vendors, fuse various sensor inputs to provide more accurate, actionable information, and automate response. The ViaLogy SPM™ solution provides all of these functions to finally realize the vision of intelligent, scalable sensor networks.

**To learn more about the ViaLogy SPM™ hardware and software solution**, e-mail [sales@vialogy.com](mailto:sales@vialogy.com) or call (626) 296-6330 (U.S. headquarters) or +44 (0) 207 869 7014 (European headquarters).