COTS View

Chem-Bio Sensor Platform Leverages PC/104

Mike Southworth, Corporate Communications, parvus
David Godso, Director of Engineering, Ricciardi Technologies

Many threats to our national security are visible with the naked eye—missiles, tanks and armed forces. A much larger threat, however, is unseen: biological warfare. In biological warfare viruses and biological agents are used as weapons of targeted or mass destruction. To date, no military or commercial equipment exists to provide foolproof, early-warning automated detection and identification and communication of biological warfare agents (BWAs) and events.

After September 11 and the pursuant anthrax-by-mail attacks, bio-terrorism is now perceived as a very real threat. In relatively minute quantities, BWAs are potentially lethal to large populations. In Congress, discussions are underway on multi-billion dollar spending plans aimed to counter potential attacks. Unfortunately BWAs are extremely difficult to detect and identify since they're often odorless and colorless. Complicating matters further, BWAs may not be recognized until days after initial contact or ingestion occurs.

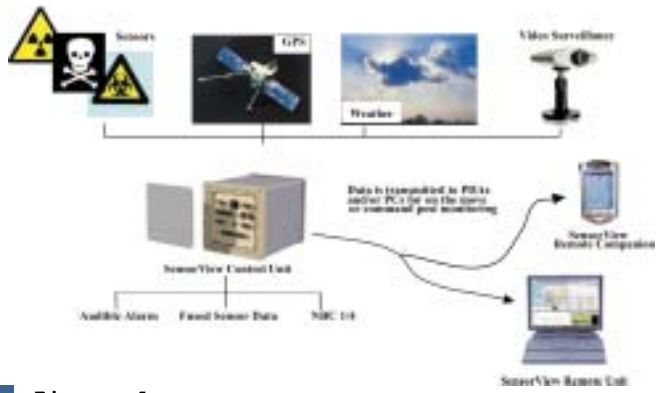

Figure 1

Developed by Ricciardi Technologies, the SensorView product suite lets users control and monitor sensor networks from the convenience of a desktop PC or wirelessly from a handheld PDA or laptop. The system uses both audible external alarms and electronic ones. It's capable of precise incident location and cloud dispersion predictive modeling using real-time GPS and tactical meteorological data.

Upgraded Bio-Detection System

Helping to mitigate the U.S. national risk is the Joint Biological Point Detection System (JBPDS). JBPDS is the world's most advanced automated biological detection system, sponsored by the Joint Program Office for Biological Defense (JPO-DS) of the U.S. Department of Defense (DoD). Prime software developer Ricciardi Technologies, Inc. (RTI) recently expanded the core networking, communications and sensor data fusion capabilities of the original JBPDS software. They also leveraged PC/104 hardware from parvus to create a new product suite called SensorView (Figure 1).

After investing several years of independent research and development funds, RTI successfully extracted key command and control software elements from the JBPDS system. RTI engineers used those elements to develop 30,000 lines of source code that today enable the system to flexibly control and configure a variety of disparate nuclear, biological and chemical detectors, collectors, identifiers and triggers. Among those are the SASS 2000 Smart Air Sampler, the Raptor Rapid Identification System, Biological Aerosol Warning System (BAWS) III, BAWS 97/98 and JBPDS. That open plug-and-play capability provides military, civilian agency and commercial customers using the system with a common interface for different manufacturer's sensors. That replaces the traditional "interface-per-sensor" paradigm—a paradigm which is not only less effective but more expensive.

SensorView combines the latest and most stable field-proven JBPDS and PC/104 COTS technologies. Its core components have gone through four-plus years of testing at military installations, while the core software has been through two sell-offs to the Joint Services for the JBPDS program under RTI's software lead.

Multiple Sensor Links

Incorporating a variety of PC interfaces—including RS-232, RS-422, RS-485 and Ethernet—SensorView allows users to flexibly control and monitor sensor networks from the convenience of a desktop PC or wirelessly from a handheld PDA or laptop. Audible external alarms, as well as electronic ones can be used in concert with the unit. The system leverages real-time GPS and tactical meteorological data to determine precise incident location and cloud dispersion predictive modeling.

This type of advanced sensor management enables agencies in large cities to integrate a variety of nuclear, biological and

Figure 2

The SensorView Control Unit (SVCU) provides the computing heart of SensorView's detection and warning capabilities. Using PC/104 allowed developers to embed PC architecture without using bulky, unreliable PC motherboards. The SVCU board stack includes parvus' Ethernet Interface, Ethernet Hub and Environmental Fan PC/104 boards.

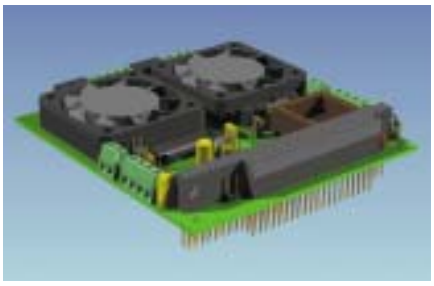

Figure 3

The PC/104-sized Environmental Fan Card provides the SVCU with intelligent thermal management. The unit also powers discrete interfaces in the system. An onboard temperature sensor monitors the unit's internal chassis conditions. The two fans circulate airflow as required by temperature conditions.

Figure 4

The SVCU communicates via Ethernet link using a NE2000/NE2000-plus compliant network interface card (left) and 4-port Ethernet hub (right). This combination lets the system access multiple networks of attached sensors simultaneously, along with wired and wireless networks and client applications. Coupled with wireless 802.11 Ethernet technology, the Ethernet subsystem can link to wireless real-time Internet Web cameras to access visual information about the validity of sensor-reported threats.

chemical sensors that can be deployed at various sensitive locations—such as near a hotel where dignitaries meet, a stadium where large sporting events are held, the governor's mansion or police headquarters. All of these locations could be monitored wirelessly by local commanders on the move, as well as from remote command posts that monitor all events simultaneously.

RTI spent more than a year in product evaluation and research to ultimately select PC/104 for the SensorView's underlying architecture. Based on desktop PC technology, yet packaged in a smaller, more durable form-factor, PC/104 has long held favor with design engineers due to its modular and cost-effective approach to embedded systems design. PC/104 provided RTI with the best overall technology platform in terms of cost, weight, size and power, while still meeting ruggedization requirements to handle potentially harsh environmental conditions.

Rich PC/104 Infrastructure

Hundreds of standard, commercially available PC/104 products are available today that offer defense applications a variety of advantages over other form-factors: PC compatibility, affordability and small 3.550- x 3.775-inch size. PC/104 also offers inherent ruggedness thanks to its 104-pin ISA bus connector and 4-point mounting, simple expandability and low power of typically 1 to 2 Watts per board. The PC/104 specification—IEEE Draft P996.1—uses the same internal definitions of a desktop PC, including bus signal timing, CPU family, direct memory access (DMA), interrupts, serial ports, network interfaces, mass storage and standardized software.

Multiple PC/104 computer boards form the foundation of the SensorView Control Unit (SVCU). The SVCU serves as the brains behind SensorView's detection and warning capabilities. Choosing PC/104 enabled RTI to embed PC architecture without having to use a bulky, less reliable motherboard- or backplane-based approach. PC/104 boards were stacked in a vertical card stack formation (Figure 2), integrating parvus' Ethernet Interface, Ethernet Hub and Environmental Fan PC/104 boards.

Tested for Rugged Role

The SVCU underwent and successfully passed multiple military testing across all four armed-services specifications in varying indoor and outdoor environments. In those tests the SVCU met all the required shock, vibration, blowing dust, fog, salt, blowing rain, High Energy Magnetic Pulse (HEMP), Electromagnetic Interference/Compatibility (EMI/EMC) and barge/explosion requirements.

Central to its military standard hardening is the cocooning of the PC/104 card stack in a proven ruggedized enclosure, such as manufactured by parvus, which integrates EMI, dust, water, shock/vibration and temperature mitigation. The enclosure acts as an aluminum shell to provide protection for the units' components, while giving ample room for signal connectors and cables.

The SVCU's Environmental Fan Card (Figure 3) provides the unit with intelligent thermal management, as well as power to discrete interfaces. An onboard temperature sensor together with two 5-volt fans intelligently monitors the unit's internal chassis conditions in a thermostatic function, circulating airflow in push-pull movements, as temperature conditions dictate.

The system's Ethernet link is comprised of a NE2000/NE2000-plus compliant network interface card (NIC) and 4-port Ethernet hub (Figure 4). They allow the SVCU to simultaneously access multiple networks of attached sensors, as well as wired and wireless networks and client applications. The SVCU provides connectivity for up to seven devices using serial interfaces. That can be expanded using more Serial Interface Cards and/or UART channels. The Ethernet cards work in tandem with

external hubs to enable an entire sub-net's worth of IP-based devices to report to a single SVCU, extending network distances beyond the 100-meter limit of the 10BaseT (IEEE 802.3) specification. Both the Ethernet interface and Ethernet hub modules are designed for highly reliable communications and minimized noise issues.

Using a standard Microsoft Windows operating system and Internet browser, users can remotely control the SVCU with the same level of command, control and information as with a local control display. That allows it to be placed at a remote location, interfaced with legacy sensors suites. The system's Ethernet hub, coupled with wireless 802.11 Ethernet technology allows it to interface with wireless real-time Internet Web cameras, providing remote operators with visual information about the validity of sensor-reported threats. Moreover, the system can communicate with common GPS satellites such as Time Mark III, NAVSTAR and handheld GPS units. Through a Tactical Meteorological (TACMET) sensor, it provides data for dispersion predictive modeling of real-time wind speed, wind direction, humidity and temperature.

Lockheed Martin selected critical infrastructure components from SensorView in a system known as "MetroGuard." Reseller KeyCrest offers a system also based on the same technology called the "KeyCrest Alert," a fully automated flight configuration of a biological identifier. These products are just now entering commercialization after their core components and technology have proven experience in the DoD.

Keeping COTS In Mind

Using commercially available PC/104 computer hardware, RTI was able to develop the next generation SensorView system without any near-term end-of-life issues. They also were able to rely on widespread vendor support for PC/104 technology, such as supplied by parvus. A large variety of open market PC/104 products are available for similar embedded applications, ranging from scalable CPUs to expansion modules, including GPS interfaces, cellular modem boards, digital input/output controllers, field bus and network interfaces, and reliable power distribution modules. PC/104 Biometrics fingerprint sensors boards and 10/100 Ethernet switches (IEEE-802.3/802.3u) are also now available for future DoD initiatives leveraging off-the-shelf components.

The JBPDS system is expected to be used for many DoD homeland security efforts by the Army, Air Force, Navy, Marines and civilian first response agencies to detect, identify and report the presence of dangerous biological agents. It will be used to save lives and collect evidence of such attacks. Arguably, the JBPDS is one of the most important protective defense programs underway in the United States today. SensorView software and hardware are based on the core components of the JBPDS and is an open, cost-effective, COTS-based product suite. As a result it's receiving significant interest from both commercial and civilian markets. ▮▮

parvus
Salt Lake City, UT.
(801) 483-1533.
[www.parvus.com].

RTI
Fairfax, VA
(703) 293-9662.
[www.rti-world.com].