Protecting the Neighborhood from Noise and Vibration with SAVE

SAVE Components in Case

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- Jean-Michel Chalons, SAPHIR

The Challenge:
Monitoring the noise and vibrations generated on construction sites to comply with neighborhood noise regulations.

The Solution:
Using NI LabVIEW software, the NI Sound and Vibration Measurement Suite, and NI WiFi data acquisition devices to develop the PC-based Surveillance of Acoustics and Vibration in the Environment (SAVE) system to wirelessly monitor acoustics and vibrations at construction sites.

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Construction sites can generate levels of vibration that can cause human annoyance and discomfort and possible building damage. Research on human response to vibrations suggests that people have an annoyance threshold far lower than any building's susceptibility to damage, even under the worst of circumstances, which is why it is important to have a system in place to monitor the effect of construction on the surrounding environment.

Creating the Cost-Effective, Flexible Hardware Architecture of SAVE

We at dB Vib Consulting and SAPHIR, a National Instruments Alliance Partner, conceived and implemented the SAVE architecture, which consists of multiple noise and vibration monitoring stations, or clients, and a central supervisor server. Users monitor the data at stations distributed throughout the site through the user interface installed on the supervisor. We designed this flexible, distributed architecture to allocate various monitoring tasks and thereby enhance performance. Each monitoring station is autonomous with respect to the central server, enabling critical tasks such as alarms and logging to be carried out locally in the event of a network disruption.

The noise and vibration monitoring stations consist of a laptop computer enclosed in a weatherproof case and connected wirelessly to the supervisor server. We instrumented each station with the NI 9233 and NI WLS-9234 C Series 24-bit dynamic signal acquisition modules. We chose the NI WLS-9234 module because of its wide dynamic range, which makes it suitable for noise and vibration measurements, built-in signal conditioning, and low-power consumption.

We conducted signal conditioning using an NI USB-9162 carrier to acquire sound level and perform a 1/3 octave analysis, and to acquire vibrations from an outdoor microphone, accelerometer, and a geophone. We could extend these monitoring stations by up to 100 m by using a remote NI WLS-9163 carrier with the NI 9234 instrumentation, which provides IEEE 802.11g (Wi-Fi) wireless connectivity for maximum flexibility. The wireless architecture offered a cost-effective extension to the system. Additionally, we used the NI 9481 high-voltage digital output module to activate audio and visual alarms for immediate attention.

We placed monitoring stations throughout construction sites in locations sensitive to noise and vibration. The supervisor automatically detected, configured, and managed the monitoring stations; acquired and displayed the data and alarms from multiple stations; downloaded and archived the files from the monitoring stations; and enabled the remote access and sending of alarms and notifications to off-site locations. The database archives retrieved, displayed, replayed, and conducted postprocessing of the measured values for reporting and exchange between different users.

Meeting Increasing Standards with the Software Architecture of SAVE

We used LabVIEW and the NI Sound and Vibration Toolkit to design the front ends, central server, and archives of the SAVE software because of the ease of use for conducting sound level and octave analysis in compliance with the applicable IEC standards including IEC 61260, IEC 61672, IEC 1260, and ISO 2631.

The acoustic requirements and analysis of a system, which can be computationally intensive, are becoming increasingly detailed. For example, the Public Health Code in France regarding neighborhood noise, which sets limits on overall sound levels (Leq), was updated in 2006. Leq is based on time-domain data; therefore, the resulting sound level does not represent any specific band of frequencies. The Leq can be no more than 5 dB(A) over the ambient from 7:00 a.m. to 10:00 p.m. and 3 dB(A) from 10:00 p.m. to 7:00 a.m. Because short-term time variations can be a significant factor in environmental noise, there are also specifications and adjustments for the duration of noise (<10 seconds, one to five minutes, five to 20 minutes, 20 minutes to two hours, and so on).

This new legislation dictates specifications on levels in particular 1/3 octave frequency bands. For example, in the octave bands centered around 125 and 250 Hz, the level over ambient noise allowed is 7 dB(A). However, the octave bands centered around 500, 1000, 2000, and 4000 Hz cannot deviate more than 5 dB(A) over the ambient noise level.

The capabilities of the SAVE modular architecture for monitoring and archiving make it adaptable to other applications. It is already being used to monitor the following:

- Gas pipelines by Gaz de France (GDF)
- Power generators by Électricité de France (EDF)
- Assembly line noise by AdduX

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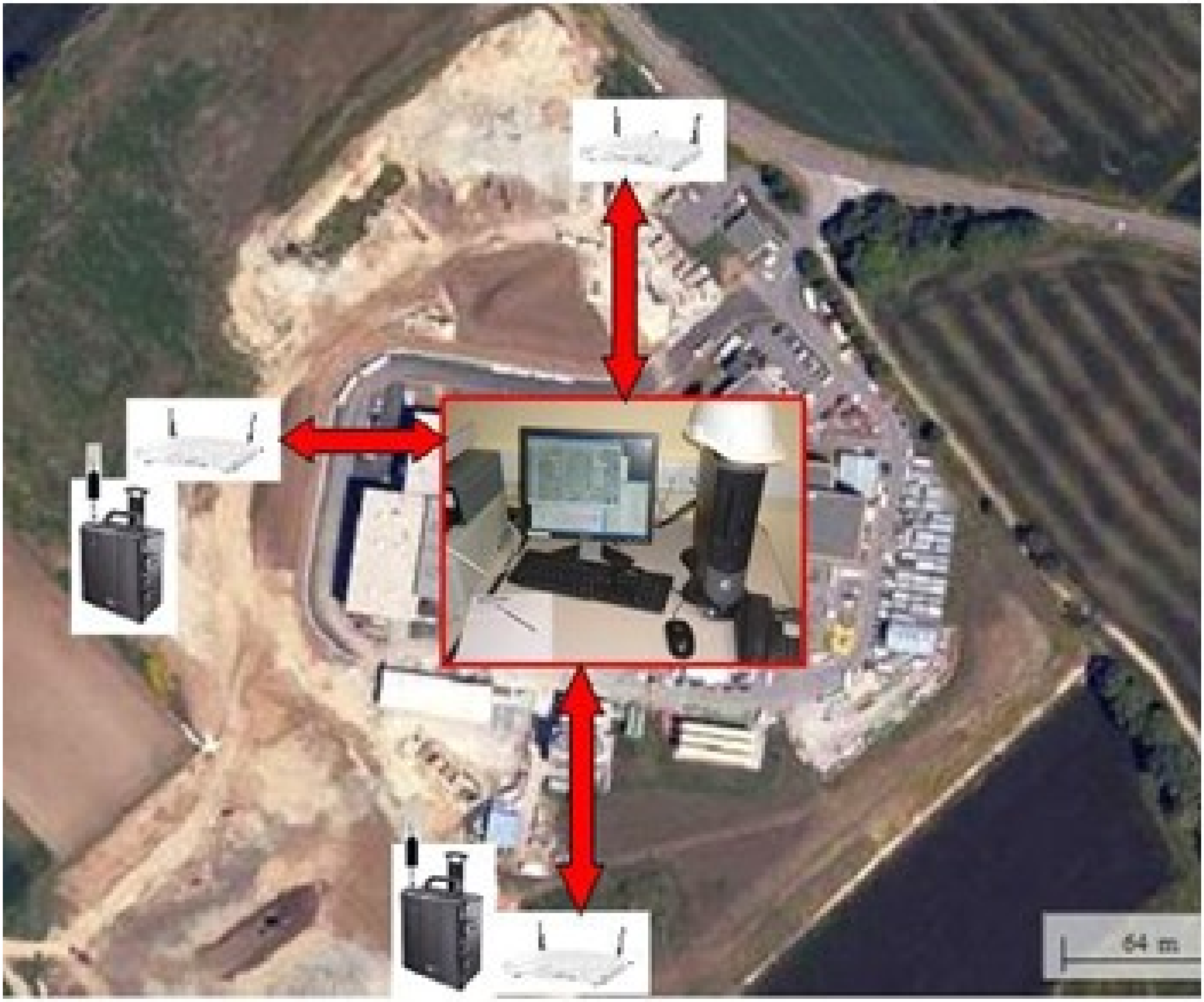
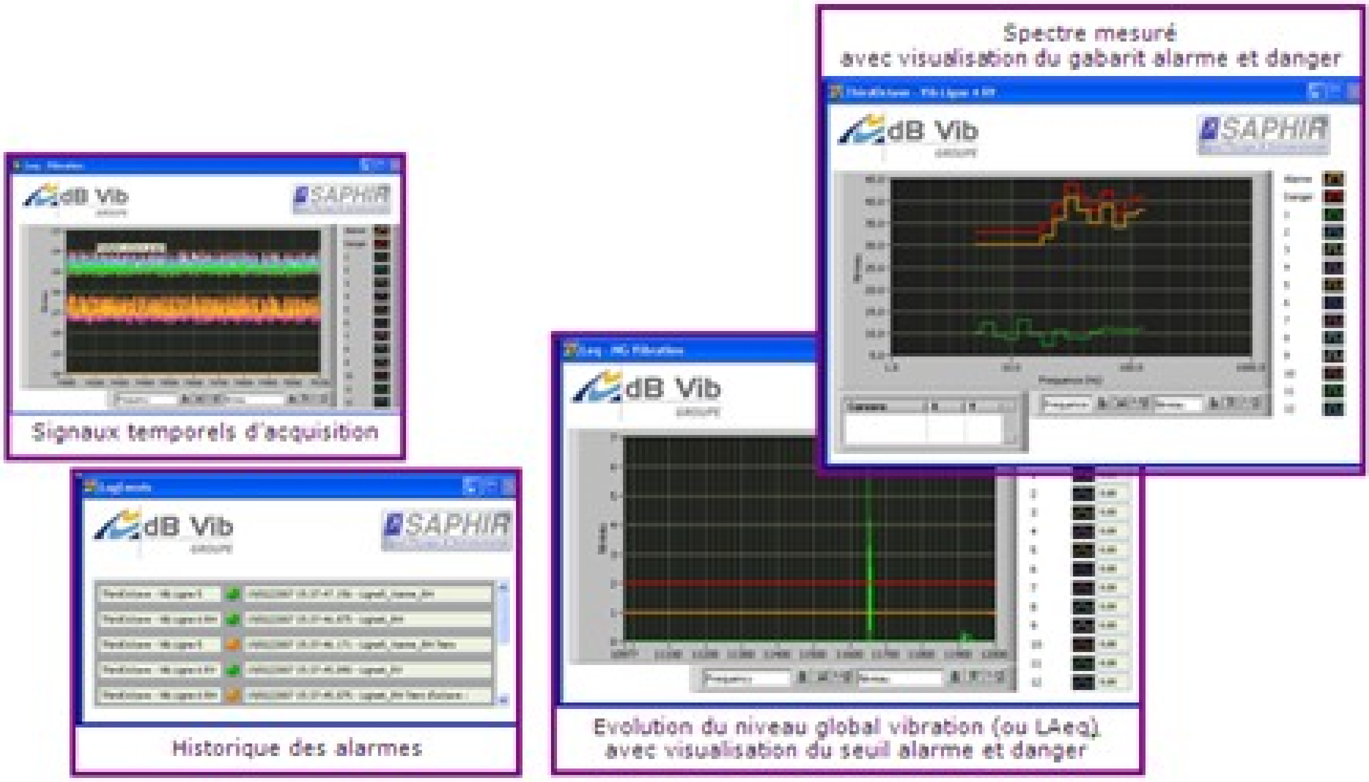
SAVE Components in Case



SAVE Deployed at a Construction Site

SAVE Front-End Components



SAVE Central Supervisor Displays
