Cloud computing for noise monitoring

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ABSTRACT
Cloud computing is the use of computing resources that are delivered as a service over the Internet. This means that software, hardware and network resources are centrally managed. The ubiquitous availability of high-capacity networks and reduced cost of both client and server hardware have led to a tremendous growth in cloud computing. The concept gives a huge benefit for both acoustic consultants and noise polluters that avoid investing time and money on expensive server hardware and installation, configuration and maintenance of software. The service provider verifies the presence and the quality of the measurements and delivers final measurement reports. This way the client can focus on their core activity. The article explains how cloud computing can be used for noise monitoring networks and give real life examples.

Keywords: Cloud computing, virtual machines, environmental noise monitoring, noise control

1. Background
According to a World Health Organisation report [1] half of Europeans live in noisy surroundings and one third of Europeans experience sleep disturbances due to traffic noise. One fifth of Europeans are regularly exposed to sound levels at night that could significantly damage health.

The European Environmental Noise Directive [2] requires that each member state produces noise maps for every city with more than 100 000 inhabitants. The noise maps shall estimate or measure the noise coming from highways, railways and major airports. Noise maps are mostly based on numerical calculations that have shown to give good estimates of long term averaged noise levels. However, such maps does not take into account the variation of the noise levels, their maximum levels coming from passing episodes such as temporary construction work, emergency vehicles, squeak from hanging brakes on trains etc. Furthermore the calculation has limitations as the complex geometry of an urban zone makes accurate calculations of noise propagation impossible. Calculated noise maps rely on input data for traffic load, terrain elevation and surface, building geometry etc. The varying availability and quality of the input data reduce the accuracy and therefore the credibility of calculated noise maps. Therefore, there is a strong need for qualifying or adjusting those maps through measurement in the field or even better dynamically feed the calculated noise maps with measured values. Also, national or local regulations often require that continuous noise measurements of noisy activities from industrial plants, construction work, harbors,
Automated environmental noise monitoring has been around for decades now, but it is only the last few years that it starts to be used by also smaller companies and independent acoustical consultants. There are several reasons for this. Communication has become faster, more reliable and cheaper. As the consumer market with handheld units such as mobile phones and netbooks with built in data modems is growing the demand for faster and cheaper solutions is pushing the providers to continuously improve their performance. With today's affordable prices of data transfer, travelling out to measurement stations to manually collect store data will normally be much more expensive than collecting data through the Internet. Also, requirements and regulations are reflecting the change in technologies and more and more often specifies that continuous, automated noise monitoring with real time access to noise data shall take place. Finally, the technology has become more user friendly. Working across computer networks has never been more easy.

2. Technology

2.1 Features in a modern software for noise monitoring

A basic software for remote noise monitoring will automatically transfer data files from the remote station and maybe also stream real time data directly to a database. However, dedicated software for noise monitoring from the leading providers in the world offer much more functionality which will give more reliability and less manual processing for the noise consultant to do.

Triggers can be set for marking noise that satisfies verify specific criteria. Duration, frequency content, time of day or day of week, level above a relative value (L_n or running L_EQ for ex.) Triggers can be used to tag data or to launch an action. An email or an sms can be sent. A picture can be taken or a video can be recorded. This can help to identify the real source of an event for later analysis.

Validation of the data through regular check of microphone signal is important. Regular verification through the use of an actuator or charge injection assures that the microphone delivers reliable data.

There must be built in redundancy in the software to minimize loss of data in case of any unexpected event. System maintenance measures can be programmed to assure continuous data flow. A typical action is a restart of a measurement instrument or modem if an error is identified. The controlling software must have a robust architecture so that data can be recovered from buffers after a communication link has been down. The software must also schedule an external backup to guarantee availability of critical noise data even after a computer failure such as disk crash, operating system failures etc.

IT systems must be protected from malignant attacks through the use of secure login procedures, virtual private networks (VPN) and firewalls.

In the most advanced noise monitoring systems a standard or a customized report can be automatically generated at regular intervals. This is time saving and reduces the chance for human errors. It rest only for the acoustic consultant to evaluate and validate the data, with the help of tags and possibly recordings and videos as well.

With long experience in delivering noise monitoring solutions we have learnt that administrating a noise system with noise monitoring terminals, communication modules and central computer unit can be challenging for many customers. The customer often has deadlines he must meet for starting noise measurements, he might have limited access to professional IT support staff to assist with network configuration and he have little time for maintaining the system. Once the system is up and running, the system is often left alone until a report shall be made after some time. If something has failed during this time, he might have lost important measurement data. This is why the leading suppliers of noise monitoring system now offer noise monitoring as a service using "cloud computing".
2.2 Cloud computing

Cloud computing is the use of computing resources that are delivered as a service over the Internet. This means that software, hardware and network resources are centrally managed. The end user will not need to install any software locally on his computer. Using cellular routers the noise monitoring terminal is connected directly to a central server hub belonging to the service provider.

By centralizing the software and hardware for multiple noise monitoring projects one achieve large scale benefits. One of those are the concept of creating “virtual machines”. A virtual machine is a software implementation of a machine (i.e. a computer) that executes programs like a physical machine [3]. One can dedicate one virtual machine for each new noise monitoring project so that each project runs on a separate virtual machine. On a single server we install a “hypervisor” – a virtual machine manager – that allows multiple operating systems to share a single hardware host. Each operating system appears to have the host’s processor, memory and other resources for itself. In addition to reduce hardware costs it’s ensures that the noise data is only available to the project owner.

The concept of virtual servers makes it very fast to setup a new server. There is no need to purchase new hardware as a virtual server can quickly be set up on an existing server provided that it has sufficient resources. However, for each virtual machine that is set up licenses for operating system and other software for that unique unit must be paid.

The hypervisor offers a centralized control platform; from one window you have an immediate overview of all your servers. Quick and efficient changes in a configuration, for example improved security protection can be replicated on all your servers. The technology offers dynamic sharing of resources so that the hardware usage is optimized. By exploiting more of the resource on a single server you reduce hardware investment and energy consumption and thereby the cost. Reliability measures such as automatic restarting of a virtual machine in case of errors can be set up. One can automate workflows to work quicker at the same time as reducing the chance for human errors.

2.2.1 Advantages and challenges with cloud computing

A major advantage of cloud computing for noise monitoring is that the customer does not need to be involved in the configuration and maintenance of the system. The service provider can remotely configure the noise parameters to be measured along with the resolution, trigger levels, conditions for starting audio or video recording and more. Furthermore system maintenance operations such as clock synchronization, microphone checks and data maintenance are scheduled. Finally one can schedule reporting formatted according to the customer’s requirement. As the system is administrated from service providers’ headquarter and set up by experts with long experience in noise monitoring the risk for erroneous setup is reduced. For the same reason, a system can be setup very fast once hardware is installed at site.

Cloud computing is generally paid for through a fixed monthly fee. The user does not have to buy a software license but instead he rent it. This reduces the startup cost and distributes the costs over time instead. In cloud computing, the provider will normally continuously develop software and make new features available for you without adding cost, as opposed to buying the software and later having to pay for upgrades in order to keep full compatibility with new versions of the operating system for example. Software maintenance being taken care of by the provider saves the client expenses for local IT support. Finally a cloud computing service can be up and downscaled easily. So once a noise monitoring project ends or is reduced in the number of terminals, the costs will immediately stop or be reduced.

The fact the noise measurements are administered by an independent service provider will normally increase the trust from the community, also in the case where the noise polluter himself is responsible for providing the noise data. Regular, automatic reporting that is published directly on the internet further increase the trust in the presented data.

On the other side one has to be prudent with safety while working with cloud computing. As the system use the internet there is a risk of hackers attacking the system. Therefore there must be used virtual private networks, strong passwords, and firewalls and security software that are continuously updated to the latest
versions. Still, many clients, and typically large companies, prefer a noise monitoring system to be configured outside of the companies’ computer infrastructure. The reason being that they will not need to allow any IT support from the provider needing to be allowed into their internal IT network. Also, the fact that the data is stored in a server park out of the customer’s office, will guarantee uninterrupted service in case of theft, fire, flooding etc. A serious service provider will have invested in safe computer infrastructure and also have a secure backup system. However, every computer system is vulnerable and there is no guarantee that failures will not happen.

A vulnerability with cloud computing is of course that it requires the user to be online, and in the case of lack of internet connection, he will not have access to measurement data. However it is rare today that one cannot find an alternative internet connection if main connection is down.

Another point to be aware of is the support level offered while using cloud computing. As the administration of the software is taken over by the service provider, the client is depending on the reactiveness of the customer support. Therefore one should have a clear agreement about expected response time when entering a relationship.

Also one should make sure that the data is transferrable if the noise project comes to an end. The formatting of data should be exportable the client will still be able to use his noise data after ending a noise monitoring contract.

3. Case study

“190 Strand” in London is a large site that had a number of vacant office buildings (figure 1). All existing buildings are being demolished and seven to nine storeys buildings are being build. Neighbors objected to the project as they were concerned about the construction impacts in the neighborhood. City of London has a Code of Practice for Deconstruction and Construction that stated what activities cannot be carried out during a quiet period [4]. Typically the overall noise limit is LAEq of 75dBA for a 10 hour period. The municipality required continuous noise monitoring in four of the closest buildings during the construction period.

![Figure 1 – The boundaries for the demolition zone and its neighbors](image)

For the project four Norsonic Nor1530 terminals with 3G modems was installed (figure 2) and the hosting service was provided from Norsonic server hub in Norway. The system is setup to generate automatic reports and send email and SMS warnings when threshold limits are exceeded.
The system is set to have two threshold values for LAeq,15min one for normal working hours and one for the quiet period. In addition an alert is set for high LEq,1h levels. An automatic report with graphs and numeric data (extract in figure 3) is generated automatically by the end of each day and is available for download through a secure ftp site immediately thereafter.

“Quiet hours” are between 14-18.
4. Conclusion

The maturity of automated noise monitoring systems “in the cloud” has now come to a level where it offers the most time saving, reliable and secure noise monitoring solution available. Being aware of the pros and cons of cloud computing for noise monitoring summarized in this article the client can make a well informed choice of technology for his noise monitoring project. For the client, whether he is an acoustical consultant, a local government agency or a noise polluter, cloud computing saves him time, reduce operational risk and cut start up cost at the same time as data provided directly from a renowned noise monitoring supplier add credibility to the measurement reports delivered.

REFERENCES


