Remote monitoring allows new operating practices in condition monitoring

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Abstract

The condition monitoring and diagnosis of machinery can today take place at any time and from any location. With web-based access to condition monitoring analysis applications and the latest condition monitoring equipment, it is possible to remotely monitor local or more widely distributed equipment.

Remote monitoring services allow new operational possibilities in condition monitoring. For instance, asset owners can monitor unmanned and even very remote sites, such as hydro or wind turbines. With remote technology, different stakeholders can have access to data, while specialists from different fields can take part in diagnostics and problem solving cases. By centralising the monitoring process, it is possible to standardise and synchronise procedures for more efficient predictive maintenance.

Remote monitoring services play an increasingly important role in the efforts of a modern company to institute high-quality Predictive Maintenance (PdM). Such services can offer not only increased assurance, but also flexibility. Among other things, it is possible to select a simple hosted application, or a more expansive approach that utilises the knowledge base of an experienced provider. At the same time, this enables companies to avoid the costs and other issues involved in setting up an in-house program.

This paper describes the concept of remote monitoring through practical applications. It gives an overview of why and how the concept has been taken into use in industry and what the results have been. Some ideas for future development will also be highlighted.

Keywords: condition monitoring, remote diagnostics, maintenance.

1. Introduction

Industrial processes are constantly evolving to become more optimised and more automated. The aim is to gain competitive advantage by deriving maximum efficiency out of the assets. The disadvantage of this development is that state-of-the-art processes of this kind are often sensitive to exceptions and require constant follow-up and a high level of expertise in tuning and maintaining (1). Remote Monitoring solutions enable co-
operation between several parties with specific expertise without excess costs of transferring people physically.

The need for remote monitoring and communication has already been evident for more than a decade \(^{(2,3)}\) but technical challenges and the lack of reasonable business models have delayed the large scale expansion of the use of these services.

The technology and applications used in condition monitoring are already rather mature. However, there are areas in developing condition monitoring where gains can be predicted. The first leads towards better utilisation of process and control data in surveillance and diagnostics and the second towards the development of tools and practices for a better utilisation of expertise.

2. Changing business environment

Networking has already been increasing in the industry for some time and suppliers have been given a more important role in supporting the asset owners. A schematic example of how the focus and deliverables in heavy industry, especially in the paper industry, have changed during the last few decades is shown in Figure 1. In short, it can be said that the development is a constant process where suppliers are expanding their offering to add value to their customers. While doing this they are assuming some of the responsibilities that have previously belonged to the customer.

As part of this development, different suppliers have become increasingly responsible for maintenance actions at the mill that have traditionally been performed by their customer, i.e. the asset owner. There is also a significant change in responsibility and
the overall customer relationship involved in this development between the two parties. When the targets of the asset owner are moving more and more towards high availability and improved OEE, the suppliers are also expected to bring their knowhow and to assume more responsibility in reliability development actions. Figure 2 shows an illustration on how availability is dependent on multiple factors, of which some can be influenced by the service supplier and some by the asset owner (4).

![Figure 2. Elements of availability (4) (modified)](image)

When the external partner has a major role in availability development it is essential to understand what the value that the partner brings to the partnership is. If the only value is cost saving, it may mean risking asset availability in a longer term. To be able to manage availability issues in partnership cases requires at least:

- long term commitment and thorough trust between the parties
- clear task and responsibility definitions
- clearly defined targets and performance indicators
- well-functioning tools and operating practices to manage and share co-operation data
- expertise and systems for effectively utilising data from multiple sources.

In the networked business environment it will not be possible to manage the last two topics in the list without remote monitoring.

3. Remote connections

Remote connection is a tool for adding new elements to the interaction between the mill and the service supplier. The effective utilisation of these connections can offer significant benefits to both the parties by providing a natural channel for fluent...
communication. However, it has to be understood that remote connection in itself rarely generates any significant benefits if the operating processes and practices are not tuned to utilise the new services that it allows (5). In practice, the best solution can be achieved when the whole process, including remote services and local actions, is in line and organised to complement each other.

The personnel at the mill have the best knowledge of the requirements of the end product, production process and specific environmental factors at their site. The supplier on the other hand has thorough special expertise among other things in reliability, technology and applications based on numerous similar cases. In brief, the fundamental aim with remote connections is to combine the expertise of the mill and the supplier in an effective way.

Remote support involves not only transferring bytes of data but it is the whole process that has to be clearly understood. In setting up a remote support system it is necessary to address questions such as the type of data that are needed, the purpose for which the data are used, the party in need of the data, the required response time etc. Figure 3 shows a schematic example of different options that are in use in the paper industry (1).

![Diagram](image)

**Figure 3. Communication channel varies depending on the nature of the data and needs**

1. **Personal communication** is an important part of co-operation. Traditionally, remote personal communication has been arranged by phone. Today videoconferences and web-based meetings have become more and more common. It is important to understand that personal communication will also remain one of the key elements of co-operation in the networked environment.

2. **Information sharing** here means that there is need to share data that have already been processed into a format that is useful to personnel. In practice, the data can take the form of reports, drawings, instructions for operation or maintenance etc.
3. **Data transfer** here refers to transferring bytes of actual data between computers. The nature and source of the data can vary depending on application and the direction of the data flow. For example, data can include measurement figures from a condition monitoring system, control parameters or some other production related values. In some cases it may also be useful to tune alarm limits but in general the aim is not to control machines by means of a remote connection. This link is the most demanding with respect to data transfer speed, confidentiality and reliability.

4. **Data collection** is a separate issue here. In some cases the data already exist at the mill systems, but often they have to be collected separately. The data can, for example, be derived from process control systems or from on-line condition monitoring systems or they can be collected manually by condition monitoring specialists or by operators.

4. **Cloud services in remote monitoring**

The concept of cloud computing is a growing element in business that is directly linked with the continuous development of remote monitoring services. A growing number of companies today are moving from a local application to a software application as a service (SaaS). SaaS is defined as software that is developed and hosted by a SaaS vendor and available to customers through web-based access. This is different from traditional boxed applications where end-users purchase the software and install it on their computers or servers. With the cloud services framework, the vendor owns the software and runs it on computers in its data centre (6).

For the end-user, this presents significant advantages in terms of flexibility in application licensing and related costs. Cloud services change the way in which applications and resources can be accessed without any local installations or start-up costs. Cloud services provide a more dynamic way of purchasing the licenses and resources and allow a faster start up for using applications and resources. Software patches, revisions or new versions are all automatically implemented. In addition, the software operates and performs more efficiently because the same version of the application is running in the entire network.

5. **Applications**

Remote monitoring service can be beneficial for all kinds of industries. In smaller enterprises it enables the cost effective, quick set-up of professional predictive maintenance programme and in large industries it can be used to enhance the efficiency of maintenance and to improve communication and condition monitoring results.

5.1. **Remote monitoring at a hydro power plant**

Small, and unmanned sites can typically benefit from remote monitoring services. For example, small hydro power plants often do not have an established condition monitoring process, but they have critical machinery that should be monitored. Such facilities also tend to be distributed across a wide area, which can make it difficult to efficiently monitor them with small resources.
This was the case with the owner of a small hydro power plant who had two hydro power stations that included a total of three turbines. The primary reason the plant owner was looking for a monitoring solution for its equipment was a complex problem with turbine gearboxes. Spare parts for the gearboxes had an unusually long delivery time. As a result, it was important to find a solution that would allow the continuous monitoring of this critical equipment. The plant owner had insufficient resources to arrange for comprehensive monitoring of the equipment, so a search was launched to find another solution to monitor the gearboxes and thus to avoid unscheduled breakdowns.

The plant owner decided to explore a possible solution to the problem. The situation at the plant sites was investigated and after discussions the remote monitoring service and its hosted interface applications was selected. The plan incorporated the installation of on-line monitoring units to measure two turbines on a 24/7 basis. The units were set to measure signals from the accelerometers, displacement probes and process signals to assess the turbine status. The supplier agreed to observe and report the status of the two turbines on a regular basis. Additionally, a specific operator interface was opened for the plant operators.

With this solution the plant owner achieved a quick start-up of a new condition monitoring system while at the same time gaining added benefit from the supplier’s knowledge and analysis of its equipment. Rather than investing in new personnel and time consuming training, the plant owner could focus on its core business on generating power. For the plant operator, the decision to use software as a service made the start-up cost lower than what would have been possible with its own local installation.

5.2 Large scale networked co-operation with remote monitoring support

Figure 4 shows an example of a large scale co-operation and remote monitoring arrangement that is based on cloud services. In this example, there are three partners. The first is the mill operator who owns the assets and runs a number of mills. The second one is the maintenance supplier who is responsible for the overall maintenance of the assets, and the third partner is the service supplier who is responsible of predictive maintenance through its remote and local services.
Figure 4. An example of a large scale remote monitoring arrangement

The service supplier is in this case responsible for all on-line and off-line condition monitoring measurements and some of the operational checks and measurements related to lubrication, for instance. The maintenance partner performs the actual maintenance actions and the operators are responsible for daily operational checks through the Operator Driven Reliability (ODR) concept. The operators utilise PDA equipment in their rounds. ODR can be defined as a system of involving the equipment operators in improving reliability by allowing them identify potential equipment problems and failures at an early stage\(^7\).

Operator Driven Reliability is an efficient concept to have operators involved in maintenance processes. It is a plant-wide initiative that combines people, processes and technology, but it is more a matter of how to organise the work than of technology. Similarly, it is more about making daily operator routines of checking assets more systematically instead of adding new maintenance tasks for them. For example, openness, cross-functional cooperation, communication and systematisation are the pillars in ODR. This requires that the management is committed to the process right from the beginning, fostering a spirit of teamwork instead of territory protection\(^8\).

One of the advantages of the remote monitoring concept of this kind is that when different parties use the same platform, communication between the parties becomes natural, thus improving the efficiency of the work.

All the data from operational checks and from condition monitoring measurements are stored in cloud computing and all the parties have access to the data. With this kind of an arrangement, typical efficiency improvement in resource utilisation has improved by 25% to 35%. In these cases the reliability of predictive maintenance has improved significantly, being typically 98% to 99%\(^9\).
6. Conclusions

Until recently the challenges in information and communication technology have prevented the wide utilisation of remote monitoring services in industry. The rapid development of the networks and applications has recently made it easier and much more cost effective to launch these services. Modern cloud computing technologies enable networking between different companies, thus creating possibilities for novel ways of co-operation.

Remote connection is a tool for adding new elements to the interactions between the mill and the service supplier. The effective utilisation of these connections can offer significant benefits to both the parties by providing a natural channel for fluent communication. However, it has to be understood that remote connection in itself rarely generates any significant benefits if the operating processes and practices are not tuned to utilise the new services it allows. In practice, the best solution can be achieved when the whole process, including remote services and local actions, is in line and organised to complement each other.

The technology and applications for condition monitoring are already mature today and recently remote applications have also developed to a point where they are available for most industrial applications. In future, the key question in gaining benefits is the substance of the service rather than the connection. Future development needs are in the areas of developing the service processes to better utilise the process and control data in surveillance and diagnostics and to develop tools and operating practices for better utilising the expertise of different persons in the service network.

Remote monitoring services are beneficial for all kinds of industries. In smaller enterprises they enable cost-effective, quick set-up of a professional predictive maintenance programme and in large industries they can be used to enhance the efficiency of maintenance and to improve communication and condition monitoring results.

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