Paper presented at IET International Conference on Asset Management in London, November 27th 2012.

Industrial Asset Management strategies for the Oil & Gas sector

Dr. V. Kongezos *, Mr. E. Jellum *

** ABB, Norway, valentinos.kongezos@no.abb.com, edgar.jellum@no.abb.com*

Keywords: Asset, monitoring, management, strategies, oil & gas.

Abstract

This paper discusses some key facts about the industrial asset management and the technology behind it as well as asset management strategies that ABB has deployed to some of the biggest projects in the oil and gas industry: offshore and onshore. These, amongst others, include the Ormen Lange natural gas plant which supplies to the UK from Norway over the 1,155km pipeline the longest subsea pipeline in the world and the Goliat FPSO which is partly electrified by a 106km subsea power cable, the longest most powerful cable ever delivered for an offshore application.

1 Introduction

Asset management in the modern industrial era is the enabler for optimised profits by exploiting assets to their maximum potential. Industrial asset management takes into consideration all the assets needed for production and distribution of goods and services. Therefore it is not concerned only with measurement of assets and resources but also analysing data and quickly taking business decisions based on information collected.

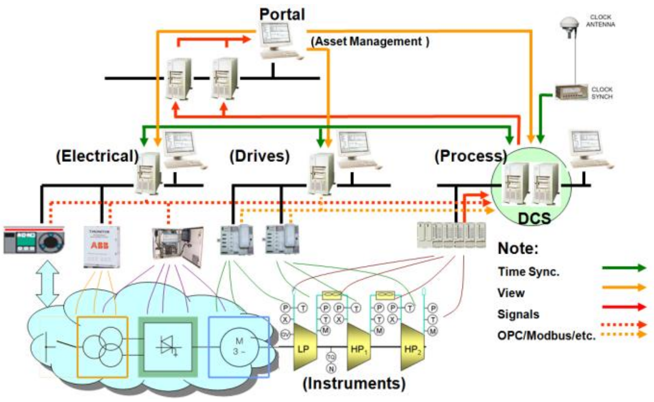

Figure 1: Asset management integration example

In the oil and gas industry the process plants are quite complex and consist of expensive and production critical equipment. As the plants condition and performance degrades over the time due to wear from several factors, this has a negative impact to the production and the costs associated with it. Asset management strategies aim to counter this impact by systematic condition monitoring of equipment to avoid unplanned production downtime and to reduce operational expenses by optimizing maintenance planning. Therefore the primary benefits of an asset management strategy are increased asset availability and performance, and maximised operations and maintenance effectiveness [1].

ABB has developed an arsenal of industrial asset management solutions that have been proven over again and cover a wide spectrum of assets that a large, digital oilfield production facility incorporates [2]. For example control system, telecoms system, electrical and power distribution system, IT infrastructure system, instruments and drives as partly shown in Figure 1.

2 Asset management - facts

Trends for the offshore oil and gas installations show that Electrical, Instrumentation, Control and Telecoms (EICT) systems are becoming more complex as the technology evolves. At the same time their performance and operational availability are critical for the production regularity. Therefore, the maintenance of the EICT systems constitutes a necessity that does not come cheap.

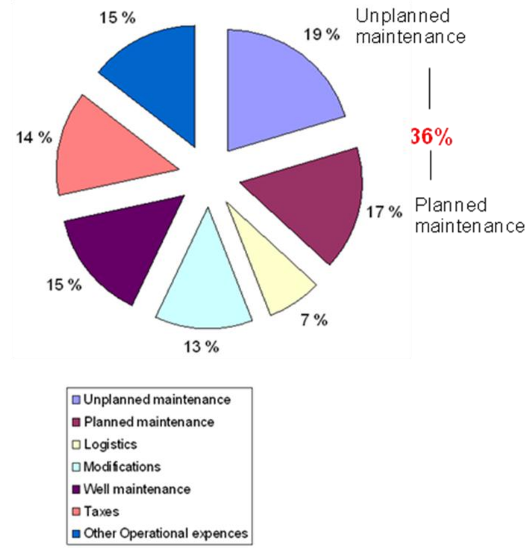

Figure 2: DNV study in OPEX of the Norwegian shelf

A study from the Det Norske Veritas (DNV), shown in Figure 2, in the operational expenditure of 10 North Sea offshore oil and gas facilities on the Norwegian shelf found that their operational expenses are estimated to be 167MUSD per year of which 40% or 67MUSD is spent on EICT maintenance [3]. From these 67MUSD 36% is spent on maintenance of which 19% (or 13MUSD) accounts for unplanned maintenance and 17% (or 11MUSD) for planned maintenance.

Based on the US Department of Energy predictive maintenance is up to 40% more cost efficient than unplanned maintenance and up to 12% more cost efficient than planned maintenance [4]. Putting these into perspective with the figures from the DNV study there is a potential saving of 6.5MUSD per year. Furthermore, cost savings can be achieved from the increased lifetime of the equipment, which in turn has savings from the reduced spare parts inventory. The Health, Safety and the Environment (HSE) are significantly improved as the chances of an accident to occur due to equipment bad maintenance are significantly reduced.

Figure 3 shows the correlation between the maintenance cost and the plants' operational availably for process regularity. Substantial cost savings and productivity gains can be achieved by adopting an asset management strategy based on maintenance practice that is both predictive and proactive – in other words condition-based [5].

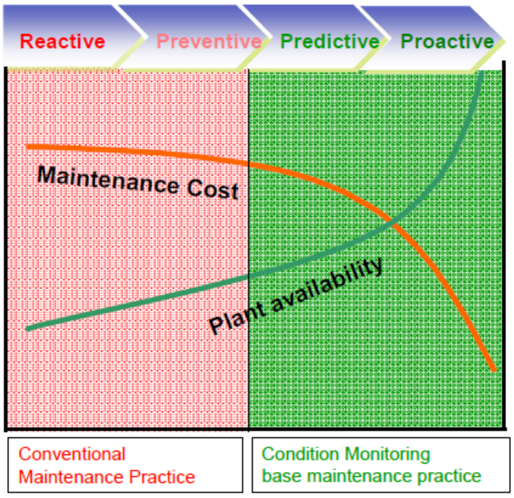

Figure 3: Condition-based maintenance costs [6]

Condition-based monitoring makes it possible to predict the condition of plant equipment based on a long time logging of data and the deeper analysis of it. Figure 4 shows the model of a predictive maintenance control loop. A sequence of tasks is initiated with the occurrence of a symptom picked up by a sensor somewhere in the plant. It continues through the detection phase that leads to a diagnosis as to what the problem is and how it affects the production. A prognosis is generated upon this information to assist during the decision making process as to what the course of action will be in order to correct the problem with as minimum as possible, if any, impact to the production schedules.

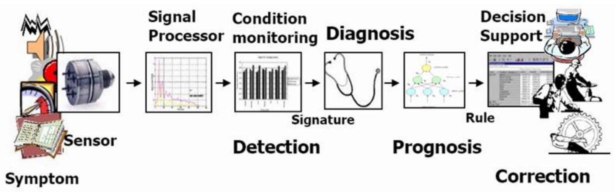

Figure 4: Predictive maintenance control loop model

3 Asset Optimisation - Meaningful information

Information is one of the most precious commodities in business today. Production facilities employing real time asset management strategies significantly increase process uptime whilst reducing maintenance costs. The challenge, though, is having relevant information available at the right time, in the right form and to the right person. Therefore, an effective asset management strategy should present real time information seamlessly and in the proper context to operations, maintenance engineering and management.

Asset Optimisation (AO) is ABB's asset management solution that provides asset monitoring, notification and maintenance workflow optimisation of automation equipment, infrastructure, field devices, electrical equipment, IT assets and production processes, all that in a real-time. It brings together in one user interface all information resident in different, traditionally disparate, automation and monitoring systems to provide a composite view of the health and performance of an asset, as depicted in Figure 5.

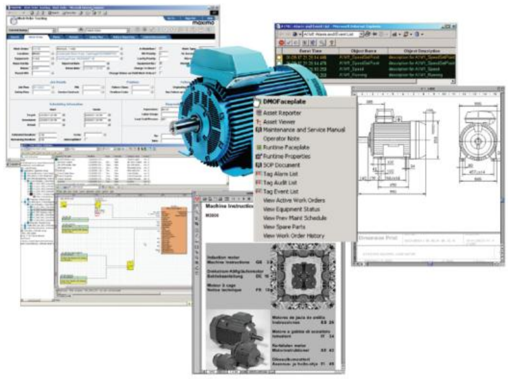

Figure 5: Asset information from different systems

AO is a software infrastructure that is designed to gather data from various sources of the plant and bring it into context of the asset [1]. Upon evaluation of the information conditions are assessed and if any degradation is detected then remedies are proposed. A fault report is generated and subsequently delivered to personnel equipped to act upon that information. AO focuses into two important aspects of the asset management. These are described in sections 3.1 and 3.2 below.

3.1 Increased asset availability and performance

To maximise the assets' availability and performance AO uses condition monitoring and condition reporting tools as it is shown in Figure 6. The condition monitoring provides supervision of the asset in real time and collects information regarding the current status of the asset and its performance. If the case of malfunction or deviation from the expected performance the operators is notified with an alarm in the workplace and also other means for example a sms or email.

The asset conditioning reporting tool shows a detailed report which can be in the form of a faceplate that informs the operator about a) what/where is the problem, b) what is the type and severity of the problem, c) how the problem caused, d) who is the appropriate operator to initiate action, e) what specific actions are needed to solve the problem. If the email or sms service is enabled then the fault report is directed to the right operator to initiate resolution of the problem.

The operator is given the capability to acquire additional information if needed to in order to make a decision which in turn can be translated for example to a work order in SAP.

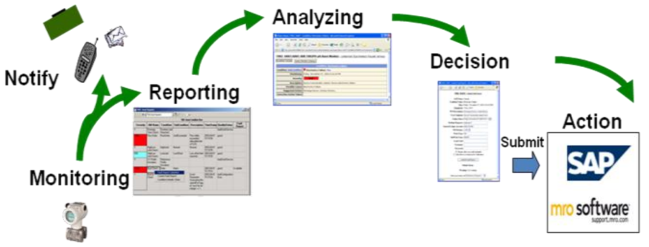

Figure 6: Asset condition monitoring and reporting

3.2 Optimised operations and maintenance effectiveness

To optimise the operations and maintenance effectiveness AO uses Computerised Maintenance Management System (CMMS) Integration and Device Management System (DMS) Calibration Integration. Maintenance operators use CMMS and DMS in their daily tasks to issue work permits, maintain inventories of spare parts, update maintenance schedules, indentify potential faults etc. CMMS data may also be used to verify regulatory compliance. Figure 7 shows in dotted lines an example of AO topology in a plant/platform with onshore operations centre.

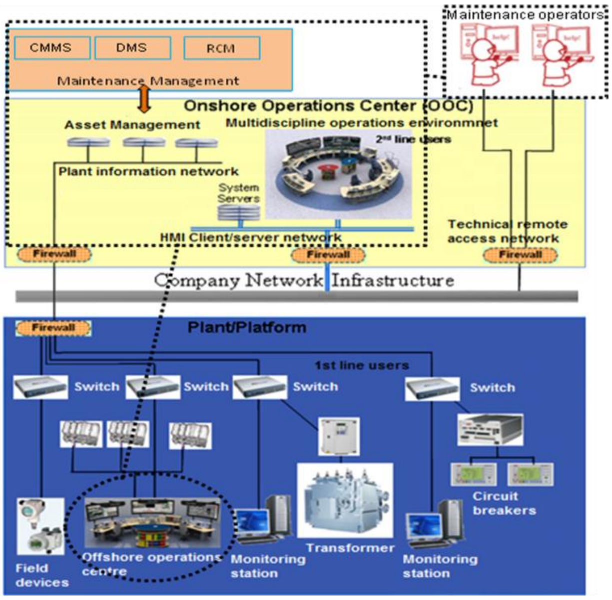

Figure 7: AO topology shown in dotted lines

3.3 Asset monitors and visualisation of information

AO gathers information from individual asset monitors. An asset monitor is an asset specific function block that verifies related input data according to implemented maintenance and diagnostic rules. It uses real-time production and control data and keeps track of the assets' performance. Asset monitors vary in complexity from those that simply identify status changes in an "intelligent" device or identify high, low, or deviation limit conditions in the control system to those that utilize advanced process equipment condition monitoring applications.

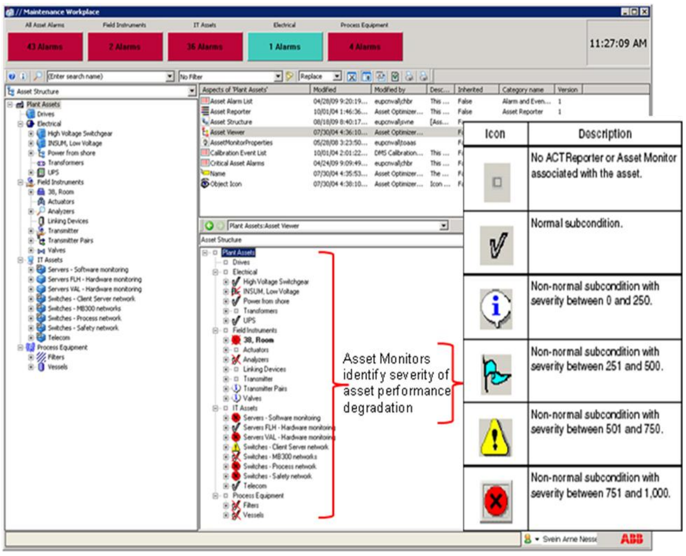

Figure 8: Example of maintenance workplace

The maintenance operator can view all the asset monitors through the maintenance workplace as shown in Figure 8. The operator with the first glimpse can identify the severity of the asset performance from the icon that appears on the side of it. The table on the right has been added to explain the meaning of the icons. Furthermore, the operator by clicking the asset monitor can obtain information regarding the cause of the fault, the severity of it, possible actions to resolve it etc, as shown in Figure 9.

3.4 Benefits from Asset Optimisation

AO allows for a high degree of flexibility when it comes to implementing the asset management strategy. The areas that it offers solutions to can be summarised as follows:

1. *Asset Optimization:* A single interface for operations, maintenance, engineering, and management to optimize asset availability and utilization.
2. *Reduced Time to Repair through Optimized Work Processes*: Integration of disparate Computerized Maintenance Management Systems (CMMS), DMS Calibration Systems, Dynamic Overall Equipment Effectiveness (OEE) Tools, and control systems streamlines work flow between operations and maintenance to reduce downtime.
3. *Automatic Monitoring of Maintenance Conditions*: Real-time monitoring and alarming of asset Key Performance Indicators (KPI's) facilitate fast, reliable implementation of corrective actions.

4. *Plant-Wide Adoption of Predictive and Proactive Maintenance Strategies*: AO collects, aggregates, and analyzes real-time plant asset information to provide advanced warning of degrading performance and impending failure, a critical component of any Reliability Centered Maintenance (RCM) strategy.
5. *Consistent Reporting of Plant Asset Health*: Visualization of current health conditions with Analysis features provides the ability to drill down to the root cause of failure.
6. *Regulatory Compliance*: With integration of the Device Management System (DMS) software, AO can provide users with traceable device calibration solutions for 21 CFR Part 11 compliance.

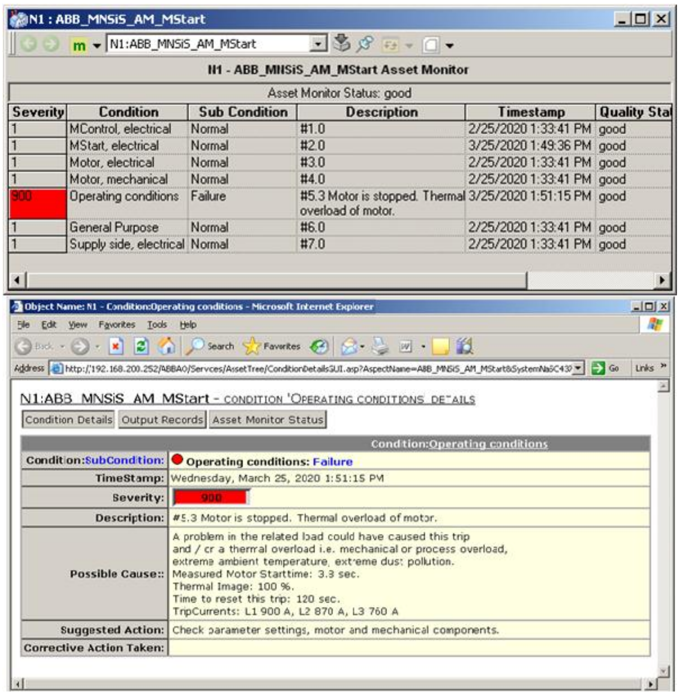

Figure 9: Example of asset monitors additional information

4 Asset management strategies implementation

When it comes to implementing an asset management strategy it is important to primarily consider the assets that play a critical role to the production and the safety of the plant. This is true especially for the oil and gas industry which is heavily regulated and potential accidents have a greater impact in the environment and, of course, to human casualties.

Another important element that should be considered is the process historian. The process historian, amongst others, logs all the data that concern an asset over a long period of time. This data is used for statistic analysis of the asset's performance and maintenance and in the longer run help to build a profile for the asset. Furthermore 3rd party software, for example Microsoft Excel, can use the process historian to extract data for creating trends, graphs and other reports that help the maintenance personnel to examine the assets' status and possible performance improvements.

Below are examined the asset management strategies that ABB has implemented to Ormen Lange gas plant and the Goliat FPSO.

4.1 Electrical system condition monitoring

The electrical power system in an oil and gas plant is one of the most critical assets that need to be monitored. Although electrical power it is taken for granted it has major impacts in the production when interruptions or disturbances occur. Likewise in a critical situation requiring a plant shutdown the electrical power system must be able to cut off the power instantly.

The Goliat FPSO will be partly electrified by a 106 km subsea power cable. The cable integrates fibre optics to monitor temperature and provide general communication services. The dynamic section, which weighs 90 kg per meter and hangs in the water between the platform and the seabed, has to withstand substantial mechanical stress from currents, waves and the movement of the platform. Therefore asset monitoring of the cable is absolutely crucial. To achieve that fibre optic Distributed Temperature Sensing (DTS) is used. Individual sections of the cable can be identified as different zones that can be independently programmed to generate an alarm via the maintenance system when the temperature in any zone reaches a pre-set limit, thus helping to both protect the cable and prevent outages. Graphical user interfaces, temperature profiles and data are integrated into the maintenance workplace, as shown in Figure 10.

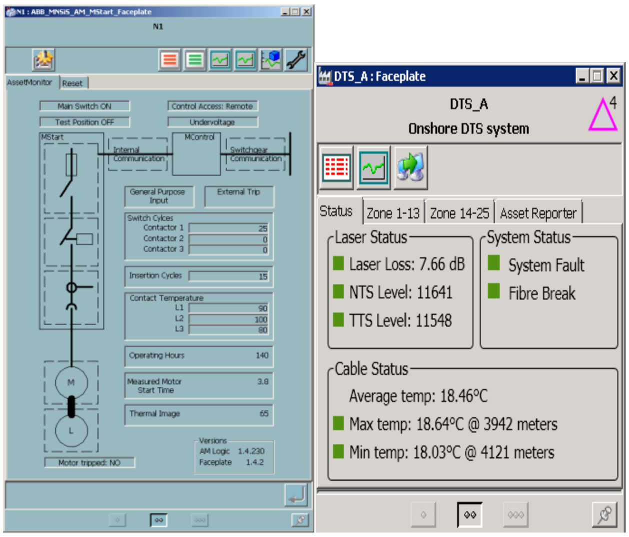

Figure 10: Contactor and DTS asset monitoring faceplates

To transform the voltage to the right level both oil-filled and dry transformers are used on both sides of the cable. The dry transformers are monitored using temperature elements integrated into the windings. For the highest voltage levels oil-filled transformers are used. The condition and the time to maintenance are continuously calculated based on oil temperature and gas sensors for the oil.

The electrical distribution system is essential for the safe operation of the plant. Breakers and contactors must be able to switch off the power during shutdowns. During normal operation of the plant many of the electrical breakers and contactors will stay constantly in either closed or open position, and this makes condition monitoring a challenge. For condition monitoring ABB has built "intelligence" into the breakers and contactors, and the condition is calculated based on the measuring temperatures, the number of couplings and the current during switching. The electrical resistance in screw joints on the busbar placed inside the electrical distribution cabinets is monitored by measuring the temperatures.

For the large electrical motors conventional vibration sensors are installed both for protection and condition monitoring. In addition the motor current is analysed to detect electrical and mechanical problems. For the smaller electrical motors wireless vibration sensors are installed for condition monitoring.

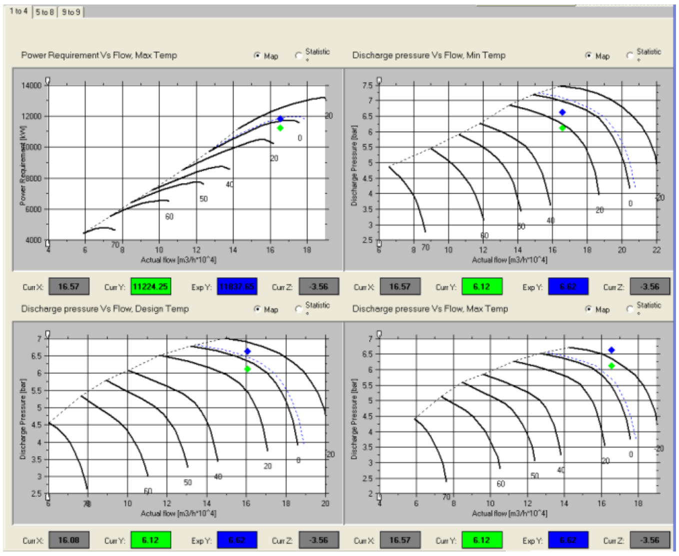

Figure 11: Compressor asset monitoring

4.2 Compressor monitoring

Compressor systems for gas processing and export are one of the most complicated and important systems in the plant. They are driven by electrical motors powered with variable speed drives which collect a large number of signals [7]. Drive monitoring systems keep track of the condition for both the variable speed drive and the electrical motor. Important parameters like the compressor's shaft torque can be derived from the electrical voltage and the current produced and measured by the variable drive. Thus the compressor monitoring is based on three sources of data:

1. The vibration monitoring system which is used both for protection and condition monitoring.
2. The electrical drive system with the variable speed drive: by utilizing the high bandwidth measurements of electrical current and voltage torsional oscillations on the compressor shaft.
3. The gas pressure, flow, and temperature before it enters the compressor and after.

The combination of the above data sets provides valuable information regarding the status of the compressor and the performance of it. Figure 11 shows an example of the compressor asset monitor for Goliat as it is presented to the operator in the maintenance workplace. The operator can examine the compressors' actual performance against the expected one and early detect any deviations that may indicate to take action before a problem escalates.

4.3 Process instrument monitoring

The process instrumentation system consists of the sensors for measuring process flow, pressures and temperatures. The positioners for controlling regulation valves and shutdown/shutoff valves and the fire & gas sensors are also included. They are all Self-Monitoring, Analysis and Reporting Technology (SMART) devices with their own built-in condition monitoring system and supporting with HART, Profibus or Foundation Fieldbus communication. The task for the asset management system is to collect the information for all the SMART devices and present it in a meaningful format for the maintenance personnel as described in section 3.4. For each device that reports a problem a description of the problem, the possible cause and the suggested action is presented as shown in Figure 9. For the Ormen Lange a report, part of it shown in Figure 12, is automatically generated with data and analysis from all the HART instruments in the plant every week and is emailed to the appropriate maintenance personnel.

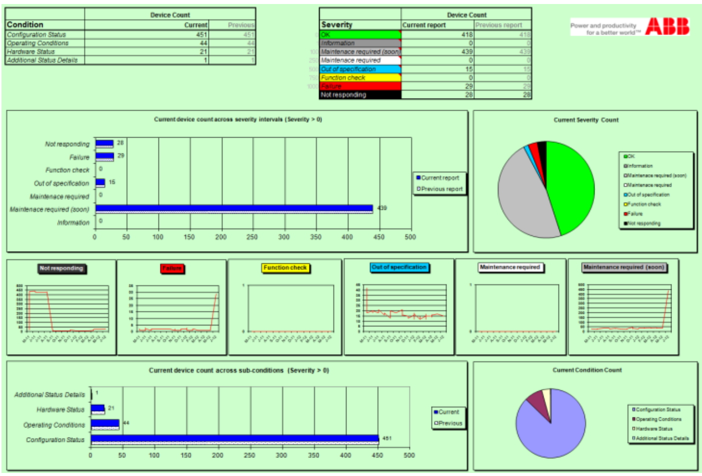
Figure 12: Process instruments report

In many cases two or more instruments collect almost the same measurement because they are mounted close to each other. The asset management system utilizes this fact to introduce monitoring of the drift in the difference between two redundant instruments. This will detect problems that cannot be picked up by the instrument itself.

4.4 IT assets monitoring

Large heterogeneous IT infrastructures are increasing in complexity as the number of interconnections between networks is growing and new "intelligent" IT devices are added. Industrial automation systems present an additional challenge, in that these control and supervise mission critical production processes [8]. The Distributed Control System (DCS), the telecoms and the remote control of the plant from onshore depend on the IT infrastructure. Thus, the asset monitoring of the IT equipment is a must.

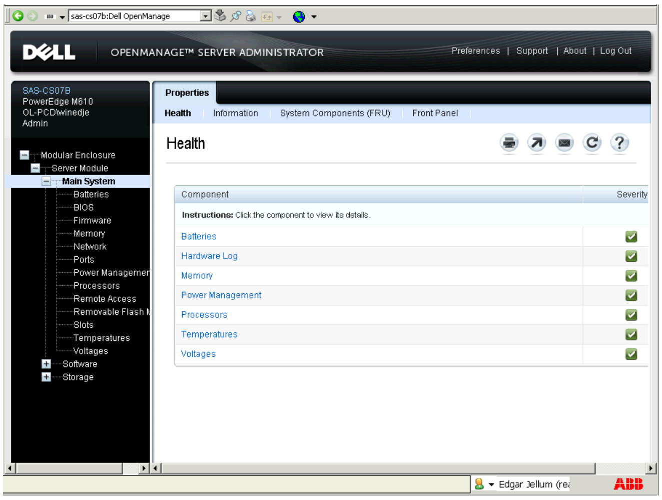

Figure 13: Windows server asset monitoring

Problems that are developing must be detected and reported in an early stage. On the servers side the parameters that are monitored would include the consumption of disk space, the status of redundant disks, the temperatures in the clusters, the CPU load etc. Figure 13 shows the built-in hardware condition monitoring as it is integrated into the asset management system at the Ormen Lange.

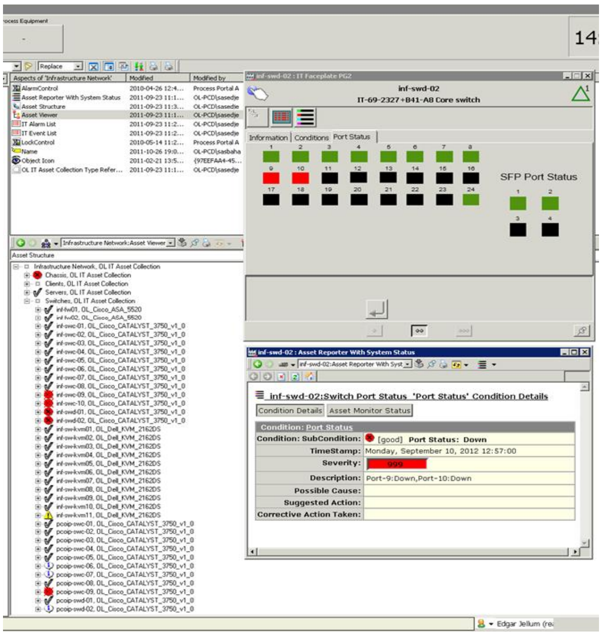

Figure 14: IT equipment and network asset monitoring

The asset management system monitors hardware and software as well as the communication network so redundant systems are ready to take over when they are needed. Figure 14 shows the maintenance workplace for the IT equipment as it is implemented at Ormen Lange. An example faceplate is also depicted that shows the active ports on a switch hub together with the asset monitor report about ports which show no activity.

5 Conclusions

Asset management is proven to be an important tool in the toolbox of a modern oil and gas plant. Key facts presented indicate the benefits in maintenance costs and production availability. It was shown that through asset management the data is collected from various equipment and systems in the plant and information is presented in a meaningful and easy accessible way to the operators who need to have it. The major aspects that an asset management strategy should focus were set and the solution of AO technology that ABB proposes was discussed as well as the benefits it introduces.

The industrial asset management strategies presented here are by no means the only ones. However they are amongst the fundamental ones for the oil and gas sector. They have been deployed to Ormen Lange plant which is fully operational since 2007 and Goliat which will become operational in 2013. The experience and knowledge from the past reveal the opportunities for the future. The technology behind the industrial asset management continuously evolves to include more assets and keep the oil and gas facilities in a regular productive state as well as making them safer for the their employees and the environment.

References

[1] ABB process automation division. "ABB solutions for asset management", Publication no. 3BUS094559

[2] Eldar Larsen, Paul Hocking. "A journey to the second generation of digital oilfields". SPE Paper 150160 Skarv and Valhall Re-development.

[3] ABB & DNV. "Studie Integrete Operasjoner Gullfaks", Study report for Petoro AS, (2004)

[4] US department of energy. "O&M best practises guide". Release 3. Chapter 5 section 5.4. http://www1.eere.energy.gov/femp/pdfs/OM_5.pdf

[5] Rajesh Tiwari, Jouni Seppala. "Effective maintenance". ABB review 2009

[6] ABB low voltages systems. "MNS iS Motor control centre", publication no 1TGC910023M0204

[7] Orkisz M. Wnek M. Kryczka K. Joerg P. "Variable frequency drive as a source of condition monitoring data", Power electronics, electrical drives, automation and motion, 2008 SPEEDAM 2008, pp. 179-183, (2008)

[8] Gelle E. Koch T. E. Sager P. "IT asset management of industrial automation systems", Engineering of computer-based systems, 2005. ECBS '05. 12th IEEE International conference, pp 123-128, (2005)

Paper presented at IET International Conference on Asset Management in London, November 27th 2012.