CHAPTER 5   ASSET HEALTHCARE

Early detection and notification of potential problems opens a window of opportunity for repair or replacement of faulty equipment, eliminating unplanned downtime and reduces maintenance time and costs (Honeywell 2004:1). Asset healthcare is a concept whereby the status of a plant and all its assets are available to be viewed and managed by maintenance staff to achieve maximum plant availability (Honeywell 2004). A process-wide view must be provided, enabling maintenance personnel to target and more closely manage plant assets that have the greatest impact on business success. This chapter describes the asset healthcare block of stage two in the SAMI triangle shown in figure 32.

Using the open architecture of the solution, it is possible for users to connect to best-in-class assets from a wide variety of manufacturers using industry standard communication protocols like Foundation Field bus, HART, Profibus and OPC (Honeywell 2004:1). These interfaces and system interfacing will be discussed in this chapter.
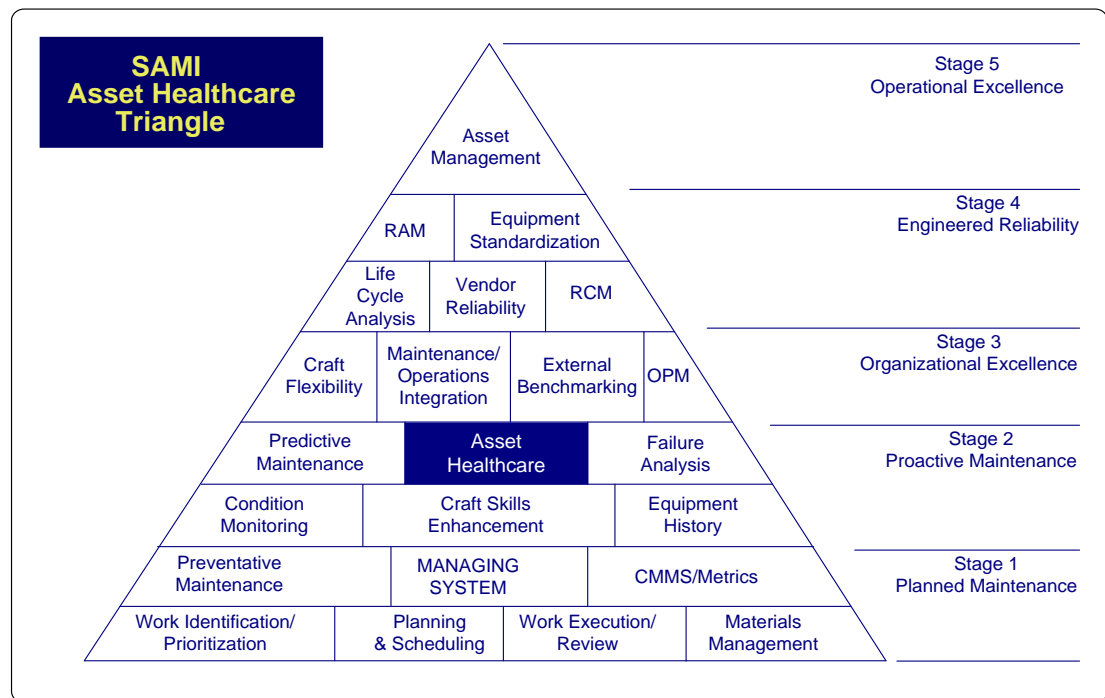

Figure 32: Asset healthcare

5.1 Introduction

The biggest problem in industry today is that asset management systems only access or manage one type of equipment or system, as marketed by companies such as Honeywell, Emerson, ABB, Metso and Endress + Hauser. An example is a solution like AMS that only addresses HART-enabled field devices and smart positioners. All these systems are stand-alone systems and to enable maintenance staff to see all assets on a plant which means that a variety of stand alone systems must be purchased and time and effort must be put in, to monitor the health of the assets (Joubert 2005).

Figure 33 shows, a group of different asset management systems in blocks. These are used in the Solvent site to access the HART-enabled field devices (Joubert 2005). The systems represented are the shutoff valve system managed by FieldCare (see 2.12), linked to the FDM (see 2.9) being interfaced to the Experion PKS R201 subsystem (Honeywell 2006). FDM is used to setup, configure and manage HART-enabled field devices (Honeywell 2006a).

Emerson's asset management system, AMS Ver 7.2 (Emerson 2006) is used to access the HART-enabled field devices and a software snap-on named Valvelink is used to access the HART-enabled smart positioners. This software allows the user to do on-line calibrations and configuration of the positioners, as well as valve signatures to determine the physical status of the valves. These valves are part of the loop management system discussed in the previous chapter.

When the research started, AMS Ver. 5.2 was the first version of the asset management system used on the Solvents site. The software was later upgraded to versions 6.0, 6.2, 6.8, 7.0 and 7.2. Only version 6.0 and 7.0 were used in the research.
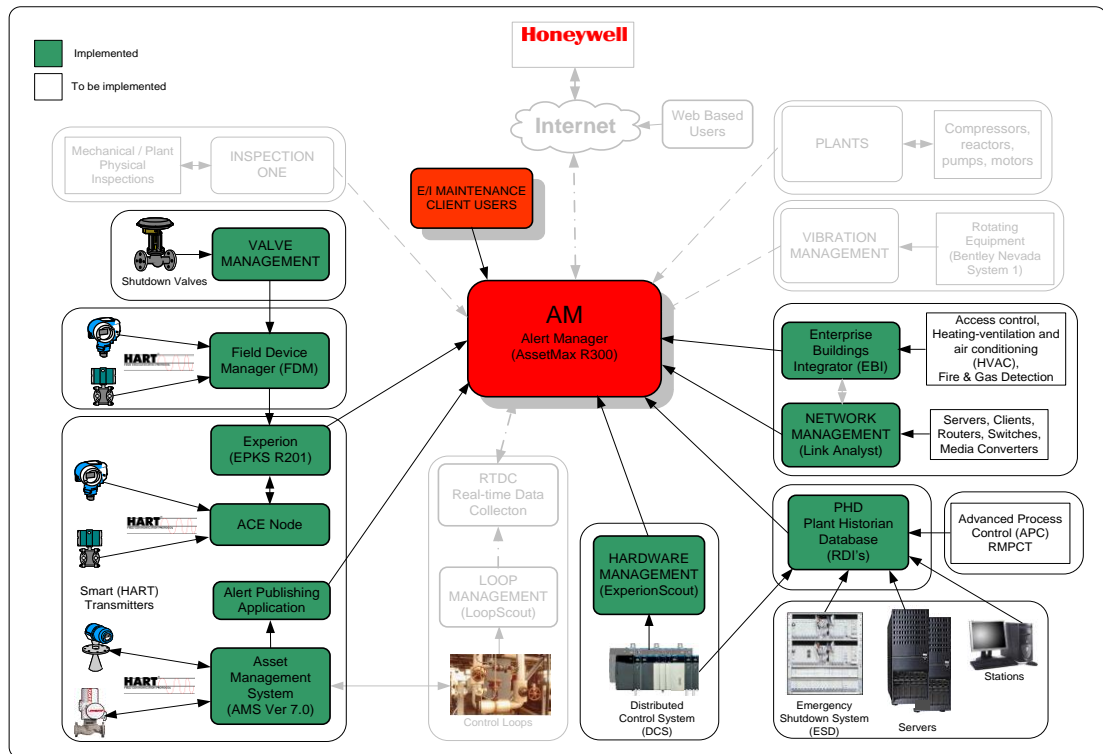
Figure 33: Integration of HART-enabled field devices to AlertManager

5.2   Asset Management Systems Integration

Integration of the diagnostic information from HART-enabled assets is achieved in two ways. The two integration strategies used are:

- Integration of existing Emerson AMS system via a custom developed interface to report symptoms and alerts to the AlertManager.
- Deployment of an Experion™ PKS R201subsystem consisting of the Experion™ PKS R201 DCS and an Application Control Environment (ACE) server is used as software multiplexer, using its native HART asset monitoring capabilities. The systems are integrated to the AlertManager.

Both integrated solutions are implemented on the three plants on the Solvents site.

90

The two asset management systems, AMS and FDM are connected to a Pepperl+Fuchs (P&F) multiplexer network (see 2.7.1). The network is split up into four multiplexer networks, each for a specific plant. Figure 34 shows the NBA, SCU and AAA System 1 plants connected to the AMS system. The AAA System 2 plant is connected to FDM and Experion™ PKS R201 systems.
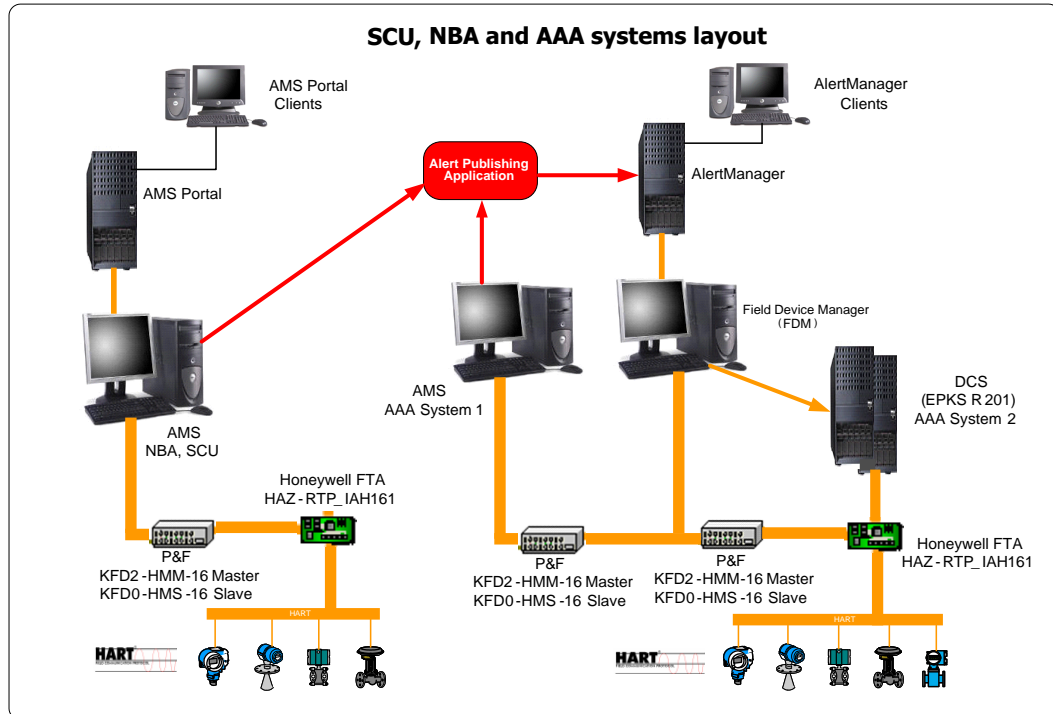

Figure 34: Multiplexer network accessed by AMS and FDM systems

5.3 Asset Management System (AMS)

Only a limited set of diagnostic information is available through the existing AMS interface. This set of information is determined by the elements that the AlertMonitor component is configured to scan for. In order to import the diagnostic information into the AlertManager, a custom interface was developed, utilising the AMS Web Services (Emerson 2005a). This interface will act as a parsing

mechanism for the information detected by the AlertMonitor in AMS. Performance of this interface is largely determined by the turn around time of fault diagnostics in the AlertMonitor.

5.3.1 AMS Web Services Alert Publishing Interface

AMS provides extensible markup language (XML) web services that may be used to load HART and FF data into business applications as well as office applications such as Microsoft Excel. The AMS Web Services make various parameter data available that can be used in a typical application retrieving this data. Client applications may be developed on any platform that supports XML web services.
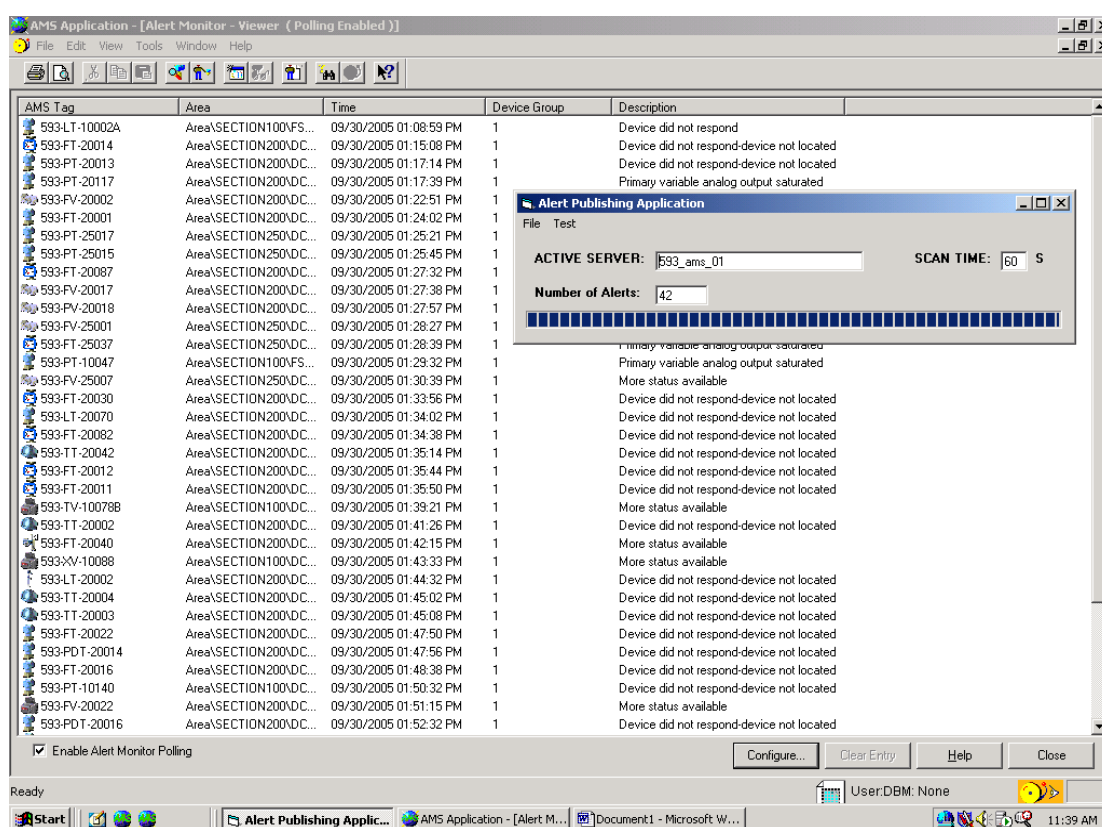

Figure 35: Alert publication application parching alerts from AlertMonitor

The alert application is developed using the AlertMonitor – alerts and poll list. This list produces the alerts from the AMS database. In the background of the running application in figure 35, the alerts that are generated by the field equipment are shown in the AlertMonitor. This is the same data that is made provided by the AMS web services. The developed application/interface uses the alerts from the AMS server which is scanned every 60 seconds, to retrieve the alerts from the database and then transfers the data to the AlertManager.

Figure 35 indicates these connections from the different AMS systems (NBA, SCU and AAA System 1) to the alert publication application and the connection to the AlertManager server which enables the AlertManager clients to access the data retrieved from the AMS systems. The alert publishing application is not used on the AAA System 2 - AMS based system. It also shows the application scanning the AMS database where it retrieved forty-two alerts from the AlertMonitor application running in AMS.

A data flow diagram is developed to ensure that all the correct systems are interfaced with the correct protocols. Performance and PlantScape RDI's is developed for PHD accessing the PlantScape DCS's and the PlantScape/Experion scouts transferring the symptoms and faults to the AlertManager. PHD uses an OPC connection to transfer the symptoms data to the AlertManager. From the FSC systems the scada points were created and linked to the PlantScape DCS. The two solutions are interfaced to the AlertManager via HTTP and API protocols. The Link Analyst application will transfer the network equipment alerts via the MkSymptoms executable. Figure 36 indicates the flow of data and the different interfaces used.
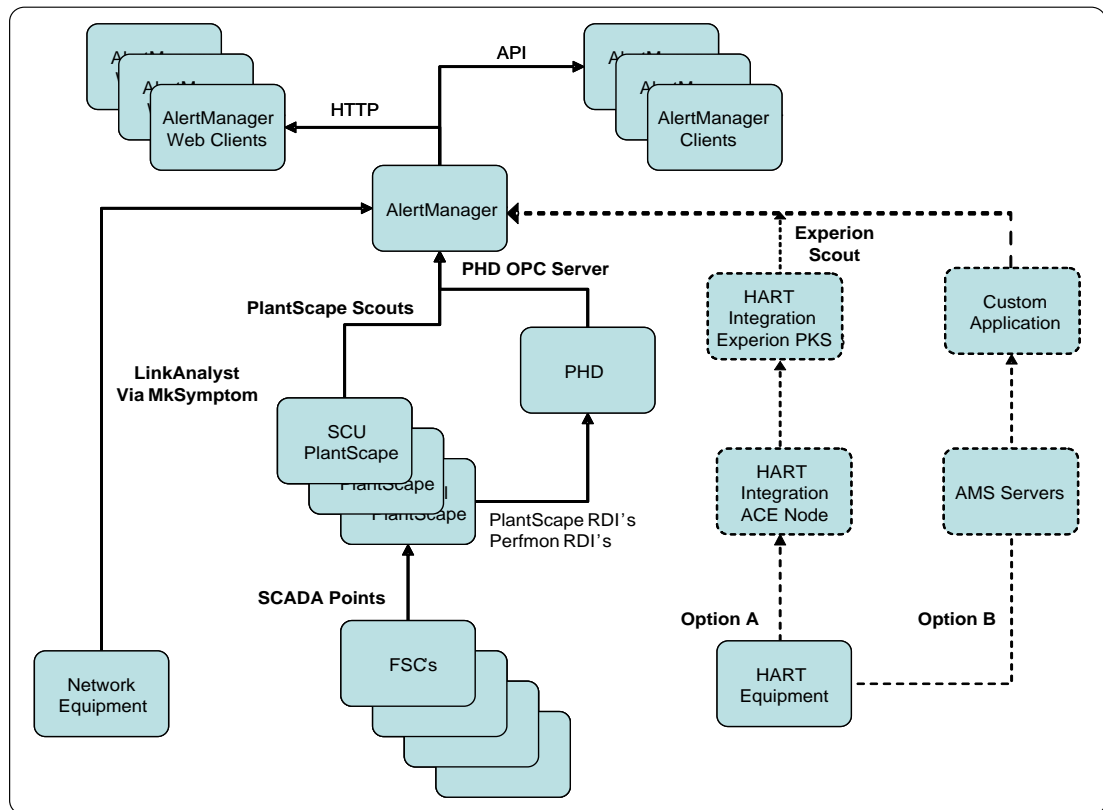
Figure 36: Data flow diagram for the two interfaces

5.4 Experion™ PKS R201

With the Experion™ PKS R201interface all the diagnostic information included in the device description (DD) files would be parsed transparently to the AlertManager infrastructure. All device specific HART Command 48 information provided in the DD files (Pratt 2002:24), will be reported in the AlertManager. This additional information facilitates troubleshooting, monitoring, maintenance and logging of device errors.

With the Experion™ PKS R201 solution a double system check is built-in, to ensure that the data retrieved from the field devices is valid and could be validated. The Experion™ PKS R201 server is connected to the ACE server (see 5.2) which retrieves the HART diagnostic information directly from the multiplexer network.

It serves as software multiplexer, converting the information from the diagnostic information to the required format to be used on the Experion™ PKS R201 software. The ACE uses its own software to detect and view the relevant command 48 data from the devices (Joubert 2005).

The FDM is connected to the multiplexer network stripping the data as previously discussed. This setup is shown in figure 14. The data retrieved from the FDM is fed back to the Experion™ PKS R201 server for validation. By validating the diagnostic data it is possible to ensure that both systems retrieve the correct data from the HART-enabled field devices. From this setup it can also be determined that the FDM reads more diagnostic information from the HART-enable field devices than the AMS system. The AMS system can only show the first seven alert bits whereas the FDM showed 128 bits of data (Honeywell 2006a). This means that more diagnostic information is available that can be used for effective and earlier warning of equipment failure, which would activate typical predictive maintenance actions.

5.4.1 FieldCare (Metso) ValveGuard interface to FDM

FieldCare software (Metso Automation 2006) is used to access and configure VG800 shutoff valves used in emergency shutdown systems as discussed in chapter two. The FieldCare package uses its own HART server and client configuration but has no open platform connections to any AMS or other asset management systems. With the introduction of FDM it is possible to design an interface that will have access to the FieldCare HART server. It is possible to retrieve the diagnostic information from the shutoff valves and make it available for transfer to the AlertManager. Figure 34 shows the FDM connection to the valve management block. The physical connection is done via a RS232 null modem connection. Figure 37 shows the FieldCare software actively monitoring the VG800 shutoff valves connected to the emergency shutdown system (FSC system).
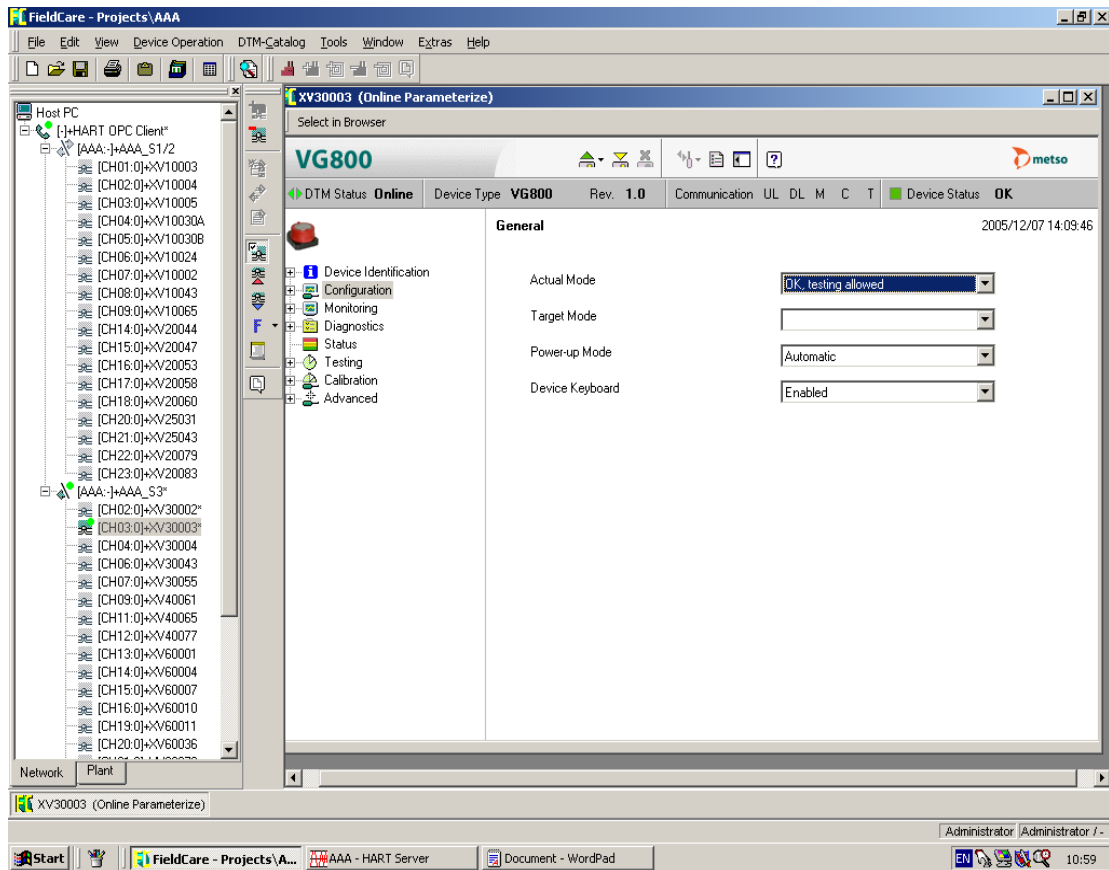
Figure 37: FieldCare monitoring shutoff valves

5.5   Link Analyst Network Alarm Detection

Link Analyst software is an intuitive solution for monitoring critical networks and the routes that connects them (Network Instruments 2006). This stand alone package is used to detect network abnormalities, device and route failures. In the Solvents environment this system is used to monitor the control network as well as the links to the business information network. The network architecture for the total solution is shown in figure 3, on page 14. The software has the functionality of creating maps of the location of servers and stations, situated on the control network. Figure 38 show an example of a typical process plant.
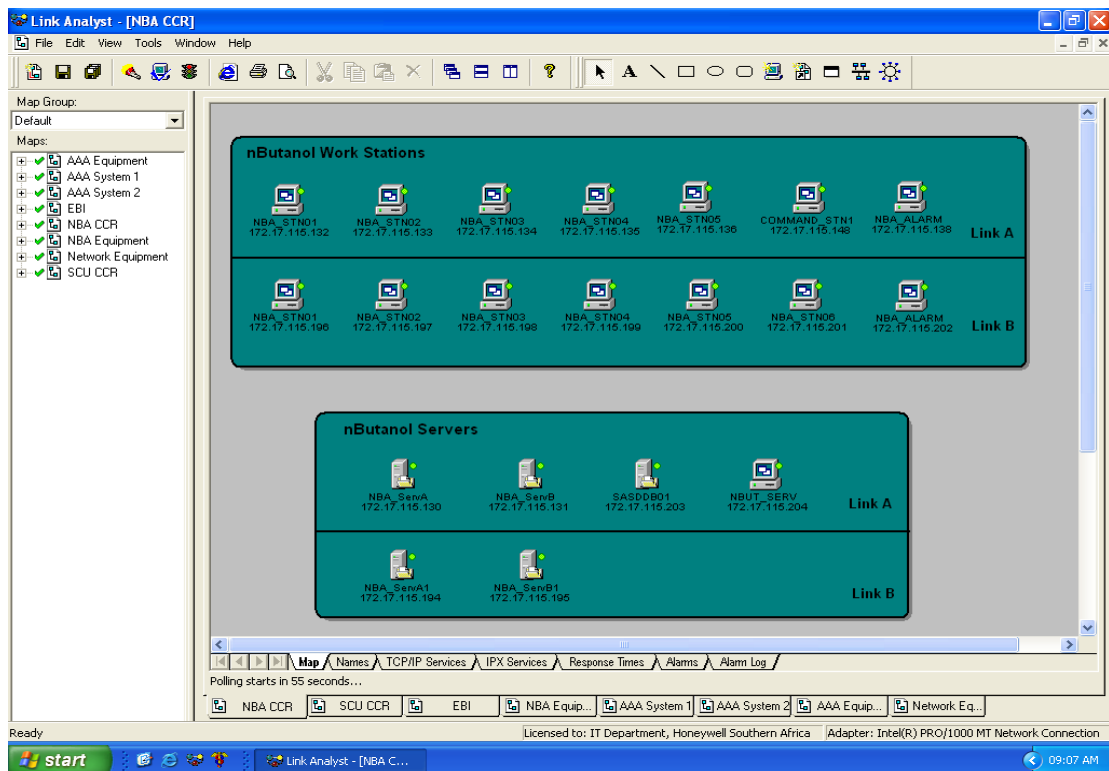
Figure 38: Link Analyst control network layout map

The different maps are created to indicate the specific plant areas and the equipment is also represented in those specific areas. In figure 38 the areas can be seen from the tree display in the maps field, on the left side of the main display. The different maps are shown as tabs at the bottom of the active map. The Plant areas defined are NBA CCR, meaning the presence of the nButanol plant in the area of the central control room, Network equipment and NBA Equipment meaning it is the equipment room in the nButanol plant area.

The need for frequent manual checks of the system led to the decision to have it re-evaluated and to possibly have it re designed. Scripting is written to enable the package to send the alerts to the AlertManager using the MkSymptoms.exe executable. When a network error occurs, the program executes the scripting that activates the MkSymtoms.exe program that parses the symptoms to the AlertManager.
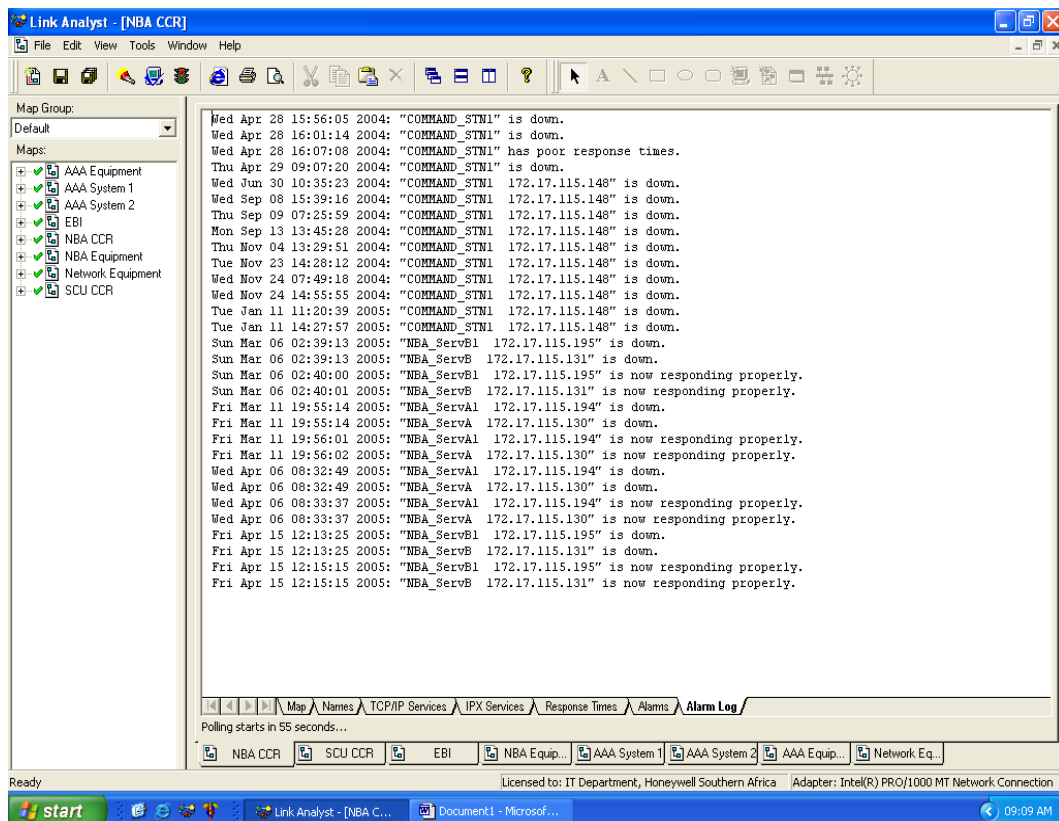
97

Figure 39: Alarm log

In the Link Analyst software package a log of all the network or device errors and alarms that are generated, is kept. It shows the time when the errors occurred and the time when the situation normalized. Refer to figure 39 for the different errors in the alarm log file.

Using the example in figure 39 it was observed that there was an error on the NBA_ServB1 server.   This server NBA_ServB1 is rebooted for maintenance purposes and the error indicated that the server is "down".   After the reboot it returned to normal again and the log indicated that the server "is now responding properly". This information is also used in a RCFA process and also forms part of the daily maintenance strategy and checks that need to be done to ensure that all network assets are behaving normally.
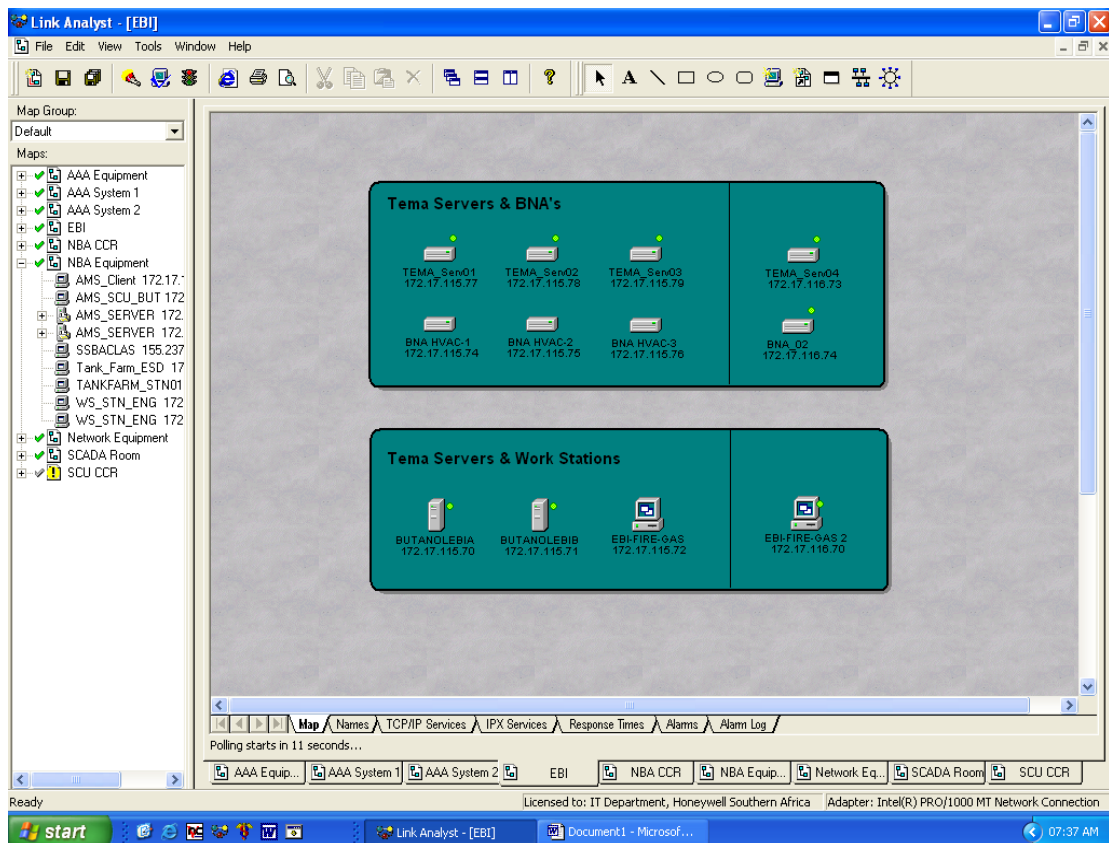
Figure 40: EBI equipment monitoring

The Enterprise Building Integrator (EBI) system (Honeywell 2004) is also monitored by the Link Analyst software. The Tema servers and building network adapters (BNA) that control the Plant Emergency Activation Plan (PEAP) system are also monitored for availability and possible network errors as they occur. The two EBI servers and their clients are monitored as a group since they are situated in the central control room. Tema servers and their associated building network adapters are each monitored in their own group since they are in the different locations on the plant. Note the IP addresses at the bottom of the devices.

This is configured to give faster access to these devices when fault finding needs to be done. The IP addresses would be used for pinging and checks through the different network switches and routers. See figure 40. It is crucially important to monitor this system since it controls such sensitive issues as, fire and gas alarms, and

the deluge water system on the different plants; things that pertain to People's safety.

5.6 ProfitController

The ProfitController is used as an advanced process control (APC) engine. It is very important to monitor this system to ensure that if something went wrong in the process or controller, it would be reflected in the diagnostics. Figure 41 shows the configured system in the AlertManager. The different inputs and multivariable variables are monitored by the APCScout.
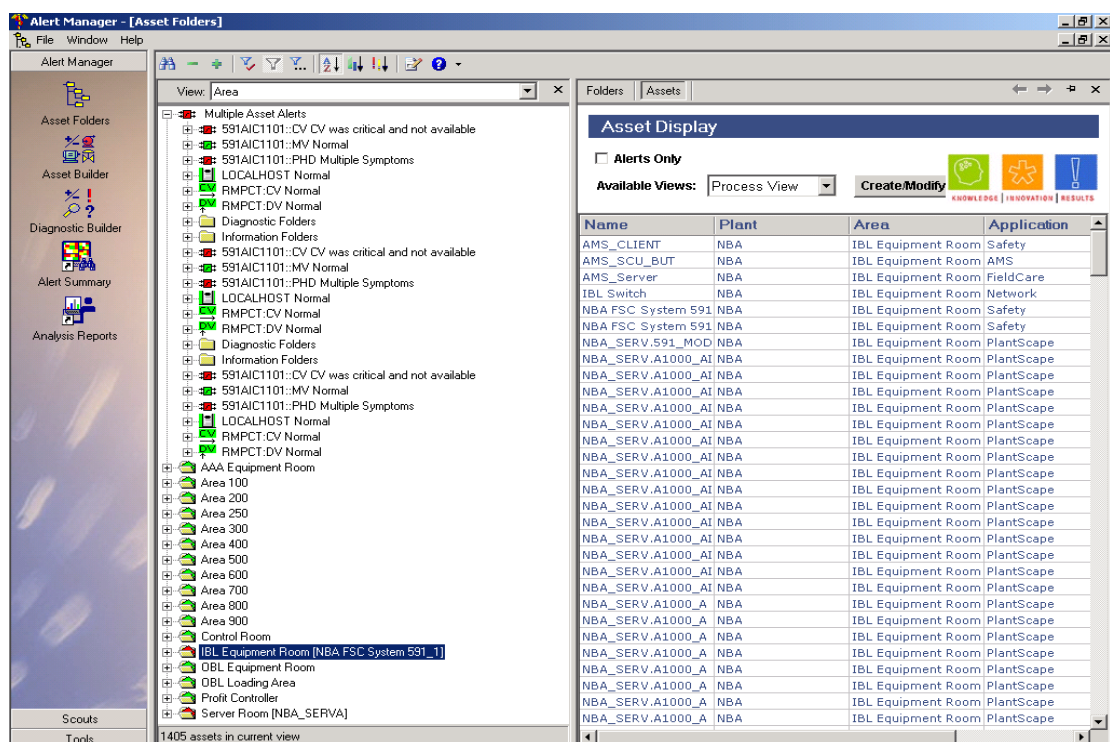

Figure 41: RMPCT assets in AlertManager

From figure 41 it can be seen that there is a problem with the RMPCT controller. The symptoms generating the faults are indicated in red. By using this view it is easier to fault find on the specific system or interface. In this case the analyzer input

was indicated, and after analysis it was found that the analyzer in the field had failed. Because the fault report in the AlertManager was so specific, it was easier to take specific corrective action in a very short time.

5.7   AlertManager plant asset views

For all the different systems that were discussed in the previous chapters, the AlertManager asset views will be viewed and the different configurations for the different types of assets will be shown.
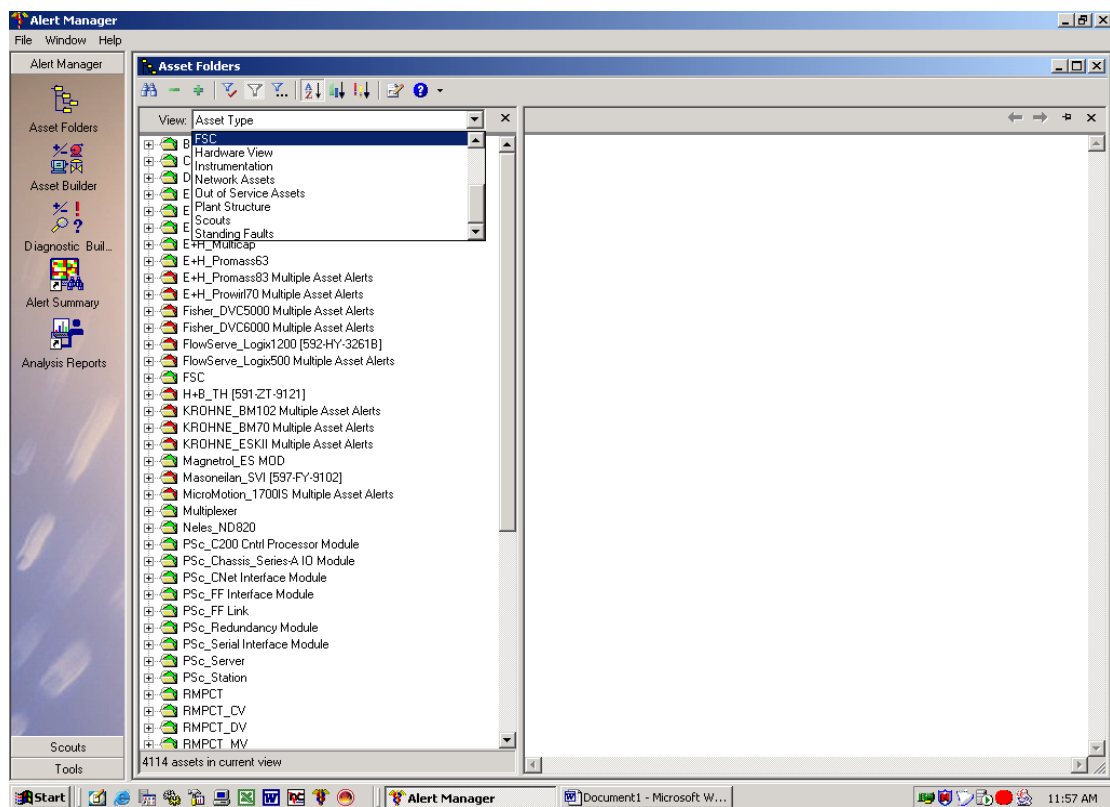

Figure 42: AlertManager view of the different types of asset groups

Figure 42 shows the different asset types that were configured using the Asset Builder. Each system with its related equipment is grouped under a particular view e.g. FSC, where all the FSC systems are monitored. By selecting the specific group

view, one can see the configured devices and systems related to this type of equipment.

The plant related views that were configured are as follows:

- Asset Type
- FSC
- Hardware View
- Instrumentation (All HART-enable field devices and positioners)
- Network Assets
- Out of Service Assets (Devices taken out of service for maintenance)
- Plant Structure
- Experion areas (Process areas in a plant configured on the DCS)
- Scouts
- Standing faults (Faults that haven't been resolved)
- DataScouts
- Areas

5.7.1   Asset Type view

The requirements for the configuration of the different plant related views were dictated by process staff and the Electrical/Instrumentation (E/I) maintenance groups as defined in the asset maintenance blueprint and FDS. By configuring the different views one can isolate specific plant areas or equipment within a specified group of equipment. Figure 43 shows all the different assets that are configured for the three different plants on the Solvents site in Sasolburg.

The assets that is built, configured and setup are as follows:

- B+R_ES
- Control loops

- Data sources

- E+H MicroPilotM

- E+H_Promass83

- E+H_Prowirl70

- Fisher_DVC6000

- FSC

- KROHNE_BM70

- KROHNE_ESKII

- Magnetrol_ES MOD

- Masoneilan_SVI

- MicroMotion_1700S

- Multiplexers

- PSc_C200 Cntrl Processor Module

- PSc_Chassis_Series-A IO Module

- PSc_CNet Interface Module

- PSc_FF Interface Module

- PSc_FF Link

- PSc_Redundancy Module

- PSc_Serial Interface Module

- PSc_Server

- PSc_Station

- RMPCT

- RMPCT_CV

- RMPCT_DV

- RMPCT_MV

- Rosemount 3051

- Rosemount 8031Con

- Rosemount 8031pH

- Rosemount 3095MV

- Rosemount 3144

- Rosemount 5081CT

- Rosemount 5081pH

- Rosemount 644

- Rosemount 8800

- Saab Level

- Scouts

- Servers

- Switch

- Workstation

- Yokogawa sc202
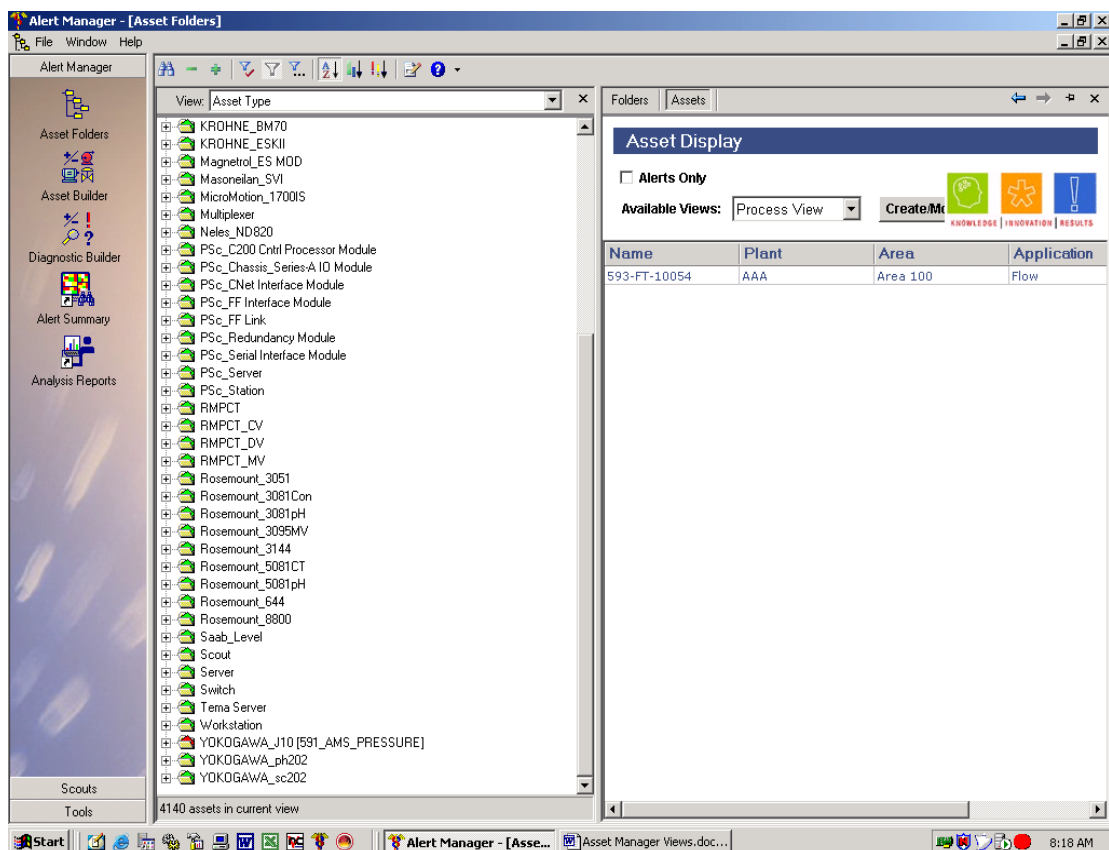
- Yokogawa J10

- Yokogawa pH202

Figure 43: AlertManager view of configured asset per type

5.7.2   Faults by Asset Type

In figure 44, the AlertManager indicates all the possible faults that are currently active for the shown assets. If the folder is red, it indicates a fault that is activated by the configured symptoms for the specific device.

Note the following example; The PSc_Serial Interface Module (Modbus) on the SCU DCS has lost communication. This is the symptom that activated the fault in the AlertManager as shown in figure 44 as example.   The DataScout on the AlertManager server failed and its condition is critical as shown in the right hand display. Note the information associated with the specific asset. The plant, the area where it is located and the system on which it is configured, as well as the status, are shown. This information is extracted from six thousand different assets on the three plants, on the Solvents site. This type of view is very crucial in the maintenance process to detect and capture the failure history to enable correcting the problem on the plant where the failure occurred.
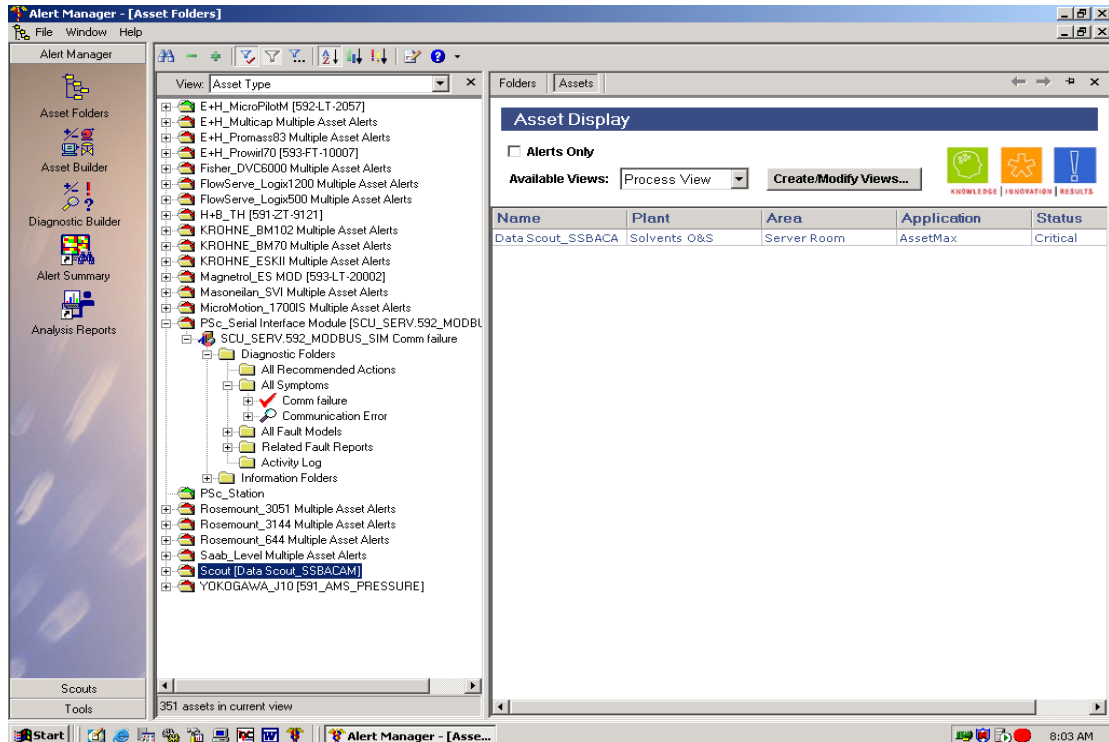

Figure 44: AlertManager view of failed equipment or systems

From the display also shows how many assets are in alarm status. In this case it is three hundred and fifty one assets. This is valuable information that is used in the RCFA process assisting engineers and field technicians to determine where, when and what went wrong with what equipment.

5.7.3   E-mail Message Notification

For each configured asset on the AlertManager, there is an e-mail maintenance message notification configured to send alerts to specific responsible maintenance personnel who will respond as soon as they get the email. A typical mail will be received in configured email program such as Outlook, as shown in figure 45. A typical alert email message is shown in figure 46. In this example the DataScout produced an error.
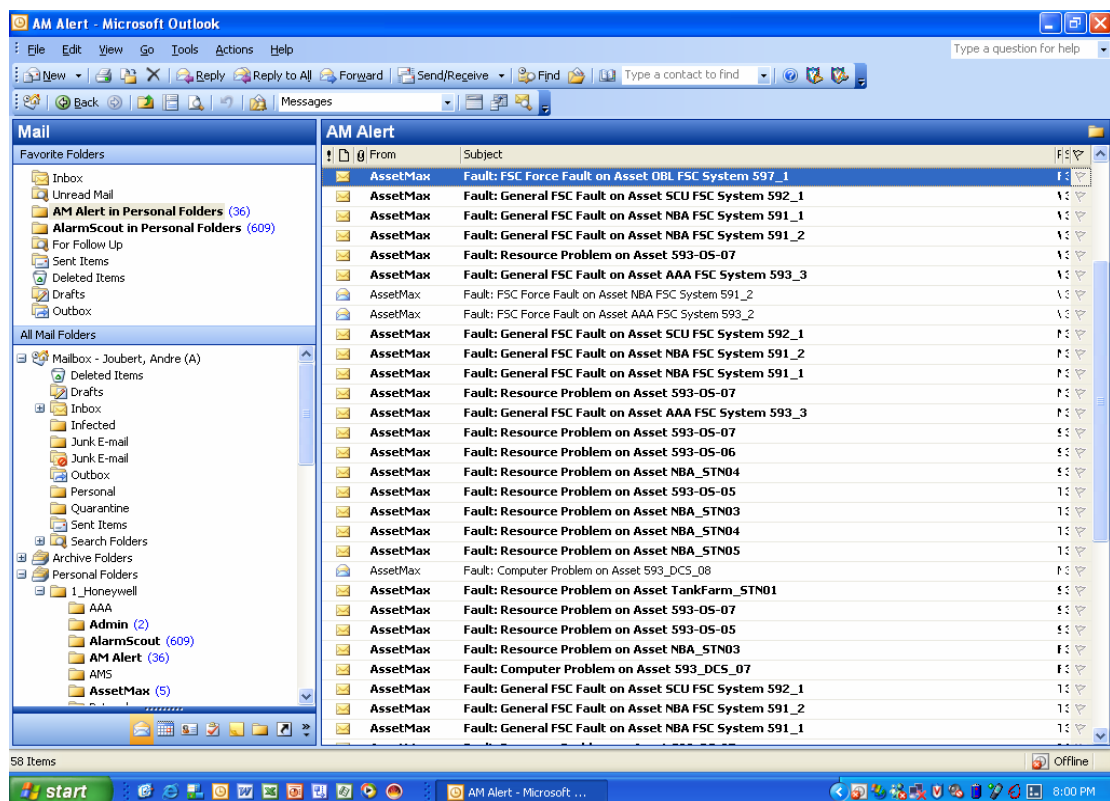

Figure 45: Mail messages in Outlook from the AlertManager

When the maintenance personnel check the AlertManager web clients for the specific faults, the recommended action for fault finding or repairing the system/field instrument will be shown in the asset infrastructure. These actions are part of the adapted work processes as discussed in chapter 3.

As part of the FSC asset configuration, a mail notification is generated if the DataScout detects a process-override condition that is active for longer than 24 hours. By law a process override may only be on for a period of 24 hours. The maintenance manager will be notified by this mail of this condition and this will then be investigated to determine why the process override was allowed for the maximum time.
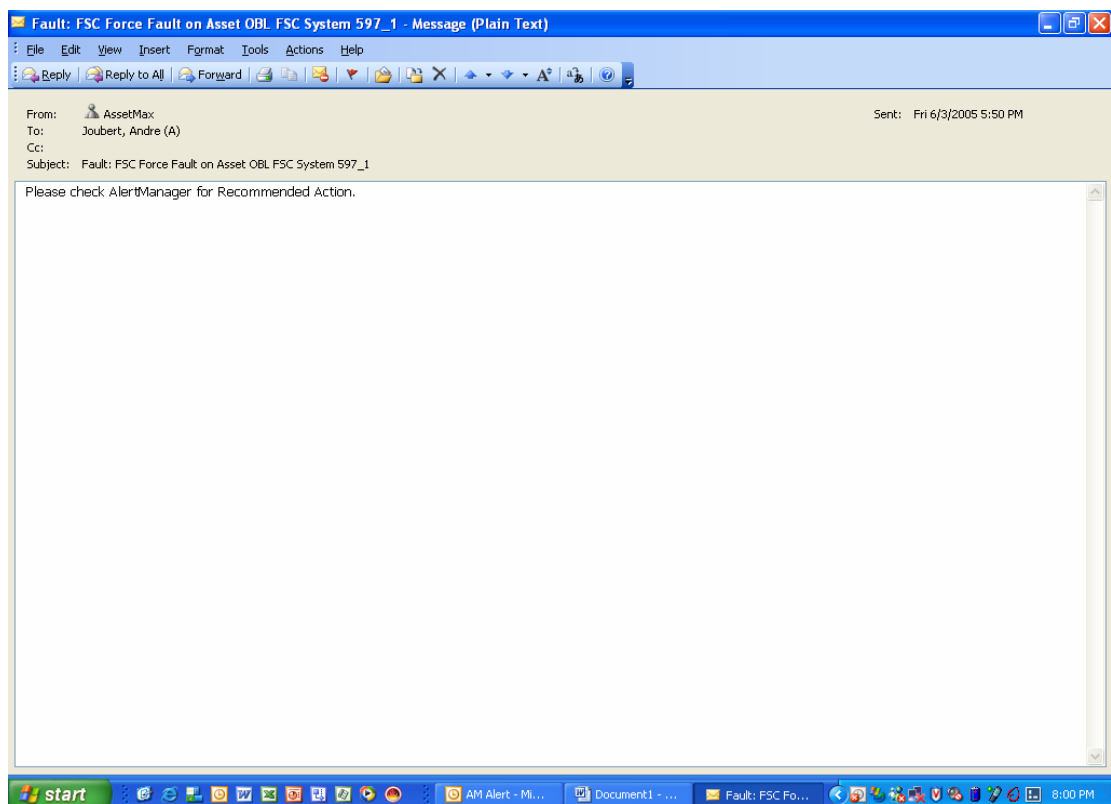

Figure 46: Mail messages contents

The total integration solution is configured and setup in such a way to adhere to all the legal regulations and compliance stipulated by Sasol procedures and the OHSA (Pruger 2005). All the configured assets are fully compliant with these regulations.

5.7.4 FSC Assets

FSC (fail safe control) assets are configured for the seven systems that are part of the overall emergency shutdown system. Figure 47 shows the FSC systems in alert. Three of the configured symptoms indicate active alerts. A closer investigation reveals that the force override key is activated for the A and B central parts (CPU), meaning that overrides can be put on from the FSC navigator work station. The third symptom means that external diagnostic information (A) is available on the FSC's Central Part_A system. This central part must be interrogated to determine where the diagnostic information points. Typically this would be an input that is disconnected from the field and the central part not being reset to clear the alert.

By having this symptom activated in the AlertManager it is then possible to detect problems on these systems without physically inspecting them daily. On the symptom history tag it is possible to see how the different symptoms is activated and returned to normal after maintenance is done. Typical times at which symptoms were active can also be monitored. This is crucial information determining the availability of the equipment and will be addressed in a later chapter.
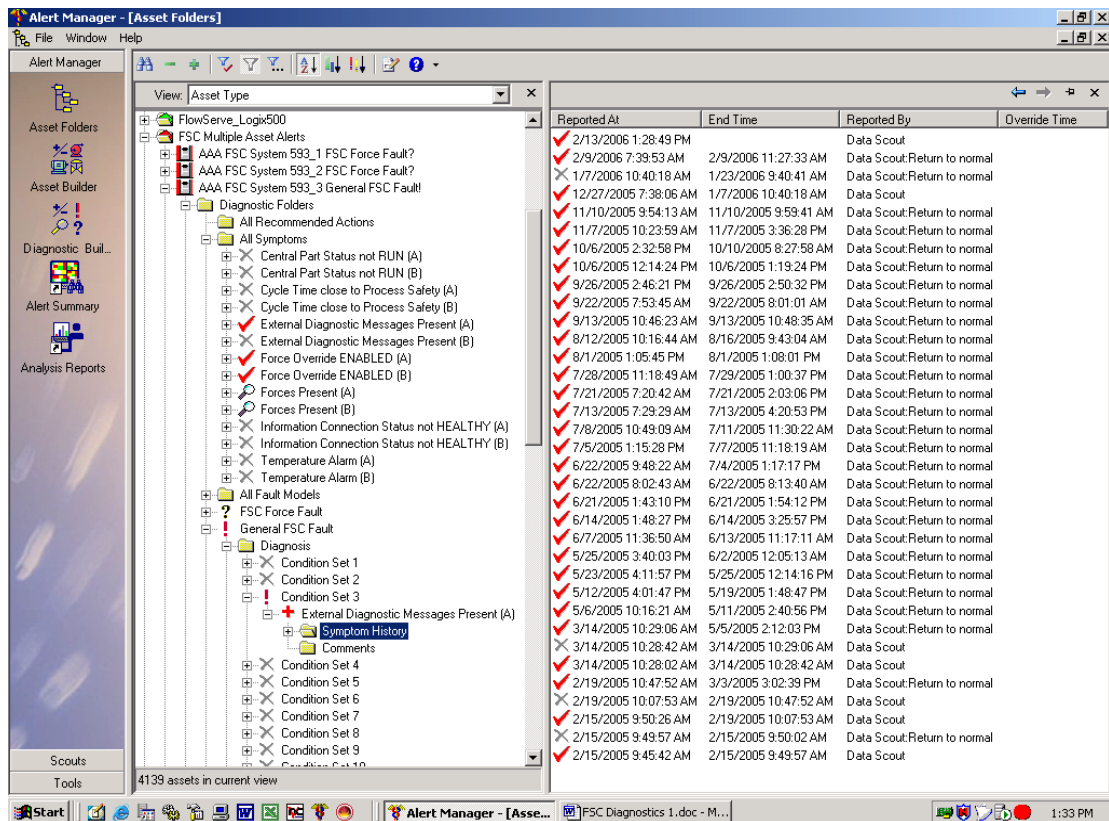
Figure 47: FSC asset information

5.7.5 Plant Structure View

In this view the layout of the different plant areas are shown and the plants have certain areas associated with them. The equipment located in these areas is configured for that specific area. This makes it easy to trace faults on equipment by concentrating on the device which monitors the area in which the equipment is located and a quicker and more effective manner.

The areas shown in the view represent the three plants, NBA, SCU and AAA. Other areas include the central control room, equipment rooms, inside battery limit (IBL) area, outside battery limit (OBL) loading area, compressors (KC101 and KC301) and specific designated areas.
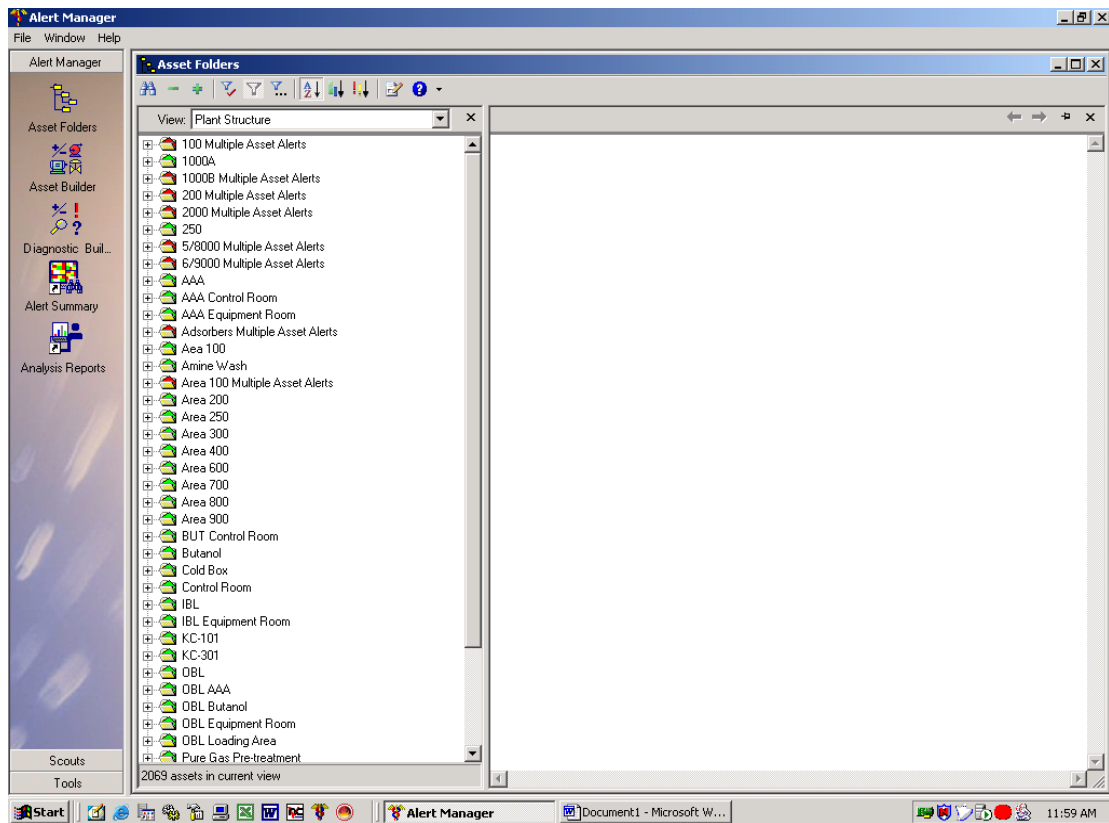
Figure 48: Plant structure view

5.7.6 Hardware View

The hardware view shows all the PlantScape equipment that are being monitored by the ExperionScout as previously discussed. All the IO cards are shown, as well as the C200 controllers and their related redundancy equipment. The PSc_Servers and PSc_Stations are also configured under this view since they are part of the control-net network. In figure 49 shows the different control net interface cards. All of these devices are shown in green, indicating no active symptoms or faults. The information folder per device will indicate the equipment that is configured in that specific group of equipment.
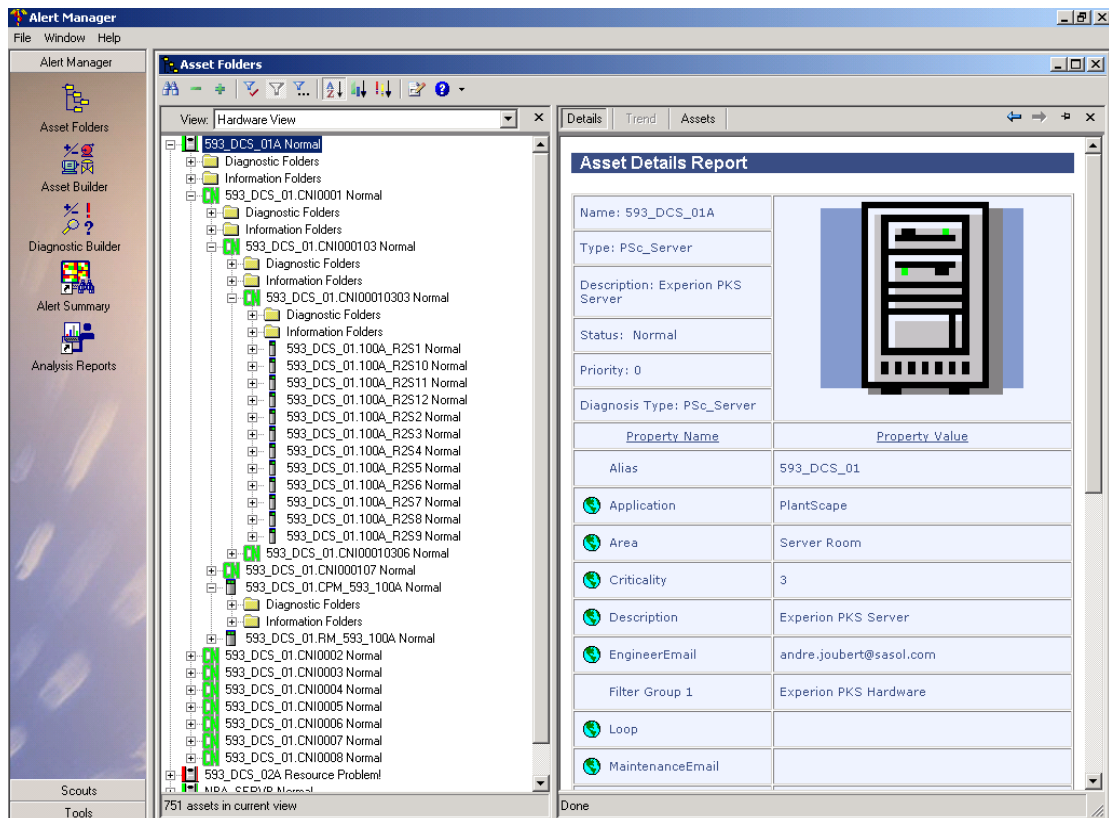
110

Figure 49: Hardware view

The highlighted asset details are displayed on the asset detail report side (right side of the display page). In this example the 593_DCS_01A PSc_Server details are displayed. The details indicate the area where the server is located, what is the status of the device, who will receive the maintenance or engineering e-mail, the group that the server belongs to and what the status is of the server. In this case it is normal, i.e. there are no symptoms. If it became active, the priority will be activated to indicate the seriousness of the failure.

5.7.7   Network Assets

All the PSc_Servers, servers like PHD and the NW_MON server monitoring the network, PSc_Stations, Tema servers, building network adapters, network switches and work stations (FSC Navigator) that are connected to the control network are part of this view.
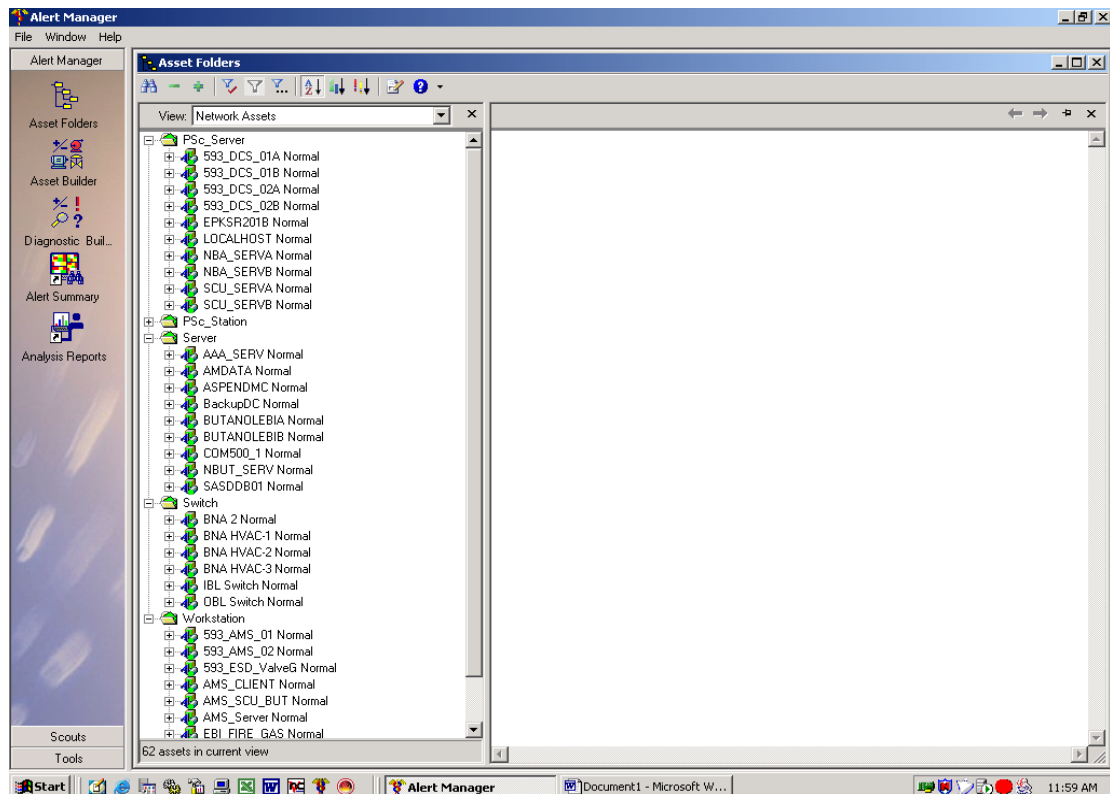

Figure 50: Network view

Link Analysis is used to monitor this group of assets as previously discussed. It is also possible to monitor the hardware resources discussed in chapter four from this view. From the server group it is possible to view the different servers that are not part of the PlantScape servers connected to the control network.

These servers that are part of the control network are as follows:

- AAA_SERV – AAA PHD buffer for the PHD shadow server
- NBUT_SERV – NBA and SCU PHD buffers for the PHD shadow server
- SASDDB01 - PHD shadow server
- ASPENDMC – APC server
- AMDATA - Real time data collector server used for LoopScout
- BUTANOLEBIA – A server for the EBI system
- BUTANOLEBIB – B server for the EBI system
- BackupDC – Domain controller server
- COM500_1 – MCC server that controls and manage the electrical motors

The different AMS systems, the FieldCare (ValveGuard) station, the EBI stations, the NW_Mon station monitoring the control network and the FSC navigator stations are grouped into the workstation group.

5.7.8   Instrumentation View

The instrument view in Figure 51 is configured to show the areas and its associated instruments types that are installed in the particular plant area.

Area 200 in the view example, show the group of instruments grouped as follows:

- Control valves
- Flow
- Level
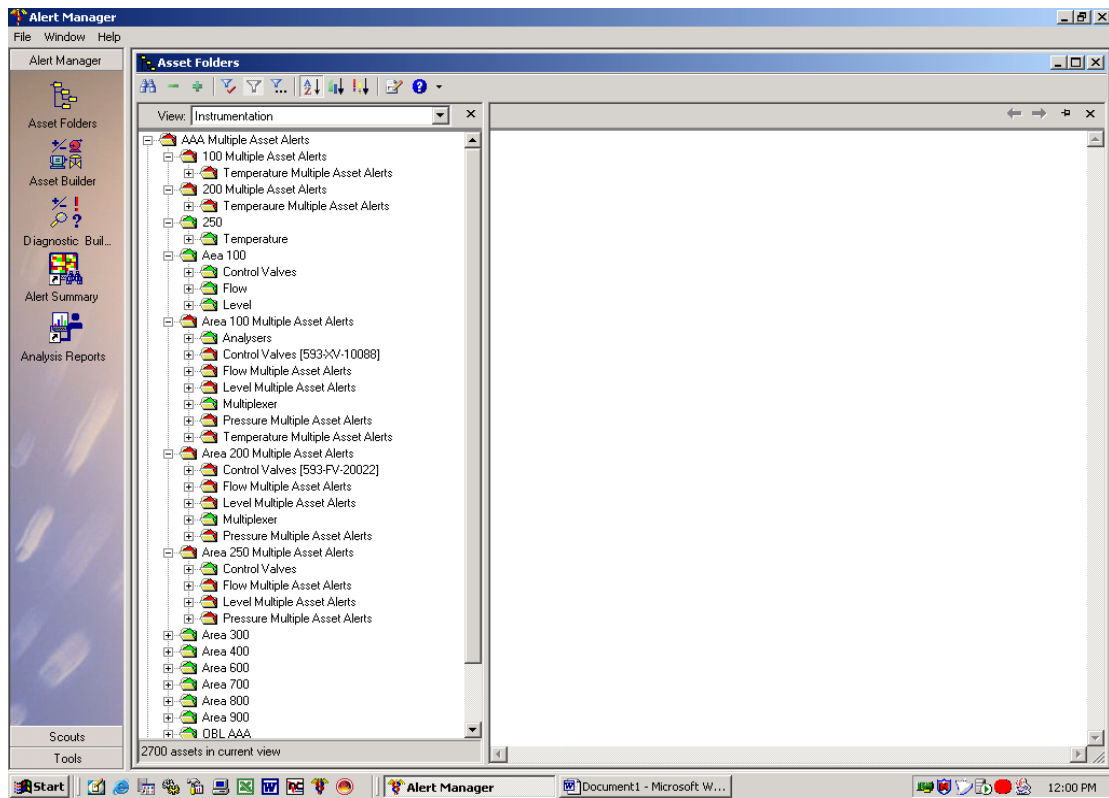- Multiplexer
- Pressure
- Temperature

Figure 51: Instrumentation view

Some areas may have analysers also added to the list. For each of these groups like the control valves, the different field equipment in the group is displayed. In the example shown, the 593_FV-20022 flow valve is part of this group and is currently in alert. The asset that is in alert is shown in red and in brackets. If there is more than one asset in the group in alert, it would be shown as multiple asset alerts.

5.7.9   Faults in the last week

All the asset faults that were generated over a period of a week are displayed as shown in figure 52. These faults show both the active and none active alerts. If the asset is opened the history in the log file can be viewed for more detail. This will be addressed in the next chapter.

114

From the example in figure 52 it is seen that there was thirty one faults during that week. This information will be used in the preventative maintenance strategy and maintenance plans where the faults per week and per month are checked against the key performance indicators (KPI). The KPI's were designed to be a measurement of the plant equipment status and health and this data is linked back to the SAMI model to determine the type of maintenance that must be done. The KPI's will be discussed in the next chapters as part of the asset maintenance process.
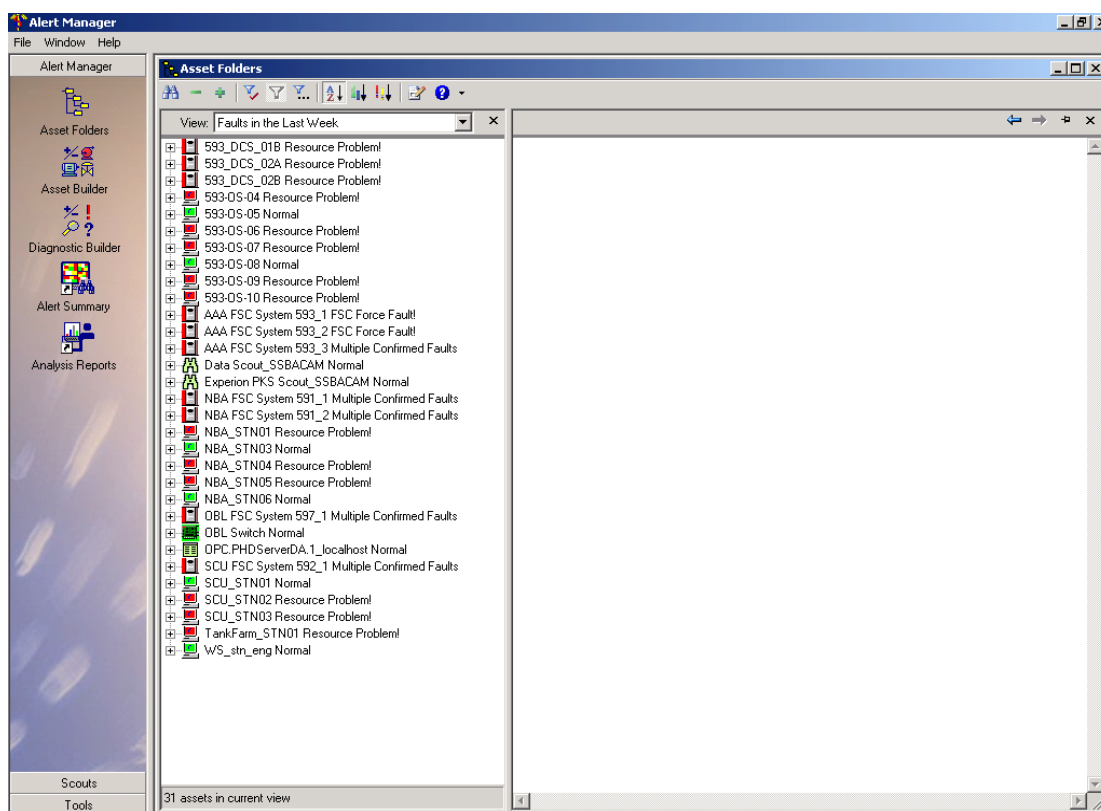

Figure 52: Faults in the last week view

The maintenance staff uses this view to verify that faults generated by the equipment are captured and that defects are generated in SAP which is Sasol's computer managed maintenance system (CMMS). This is an action to ensure that all faults are resolved.

5.7.10 Control Loops

As discussed in the previous chapter, LoopScout is used to monitor the control loops on the different plants. The uploaded and processed data that is received from Honeywell in Thousand Oaks, USA will be fed back into the AlertManager by an interface that is developed to retrieve the diagnostic information for the control loops. The diagnostic symptoms were discussed in chapter 4.
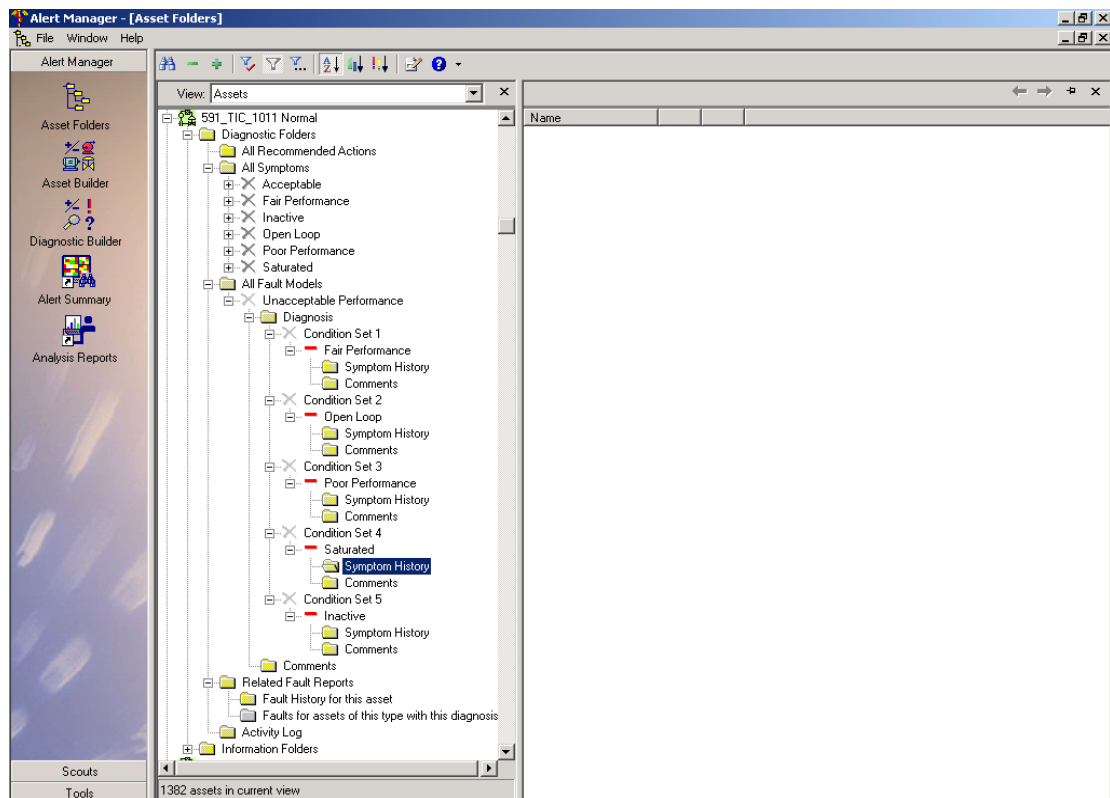

Figure 53: Asset view showing control loops

Honeywell produces a flat file for all the configured control loops and a separate diagnostic report per loop. The different reports will be discussed in a later chapter. The flat file interface strips the data from the flat file, and parses it into the AlertManager to produce the mentioned symptoms and faults that were generated from the report. An example of this is where the loop report produced a typical "Poor Performance" symptom. This would then activate the symptom in

AlertManager. Figure 53 show a temperature control loop with its symptoms and fault tree.

5.7.11 Scouts

For the total solution interfacing the different systems shown in figure 54, two scouts are used to ensure that all the required diagnostic information from these systems is received into the AlertManager. The two scouts, DataScout and ExperionScout are also monitored to ensure that they are active to retrieve the required diagnostic information from the interfaced systems. In the asset details report page the scout details are displayed. The status of the DataScout shown is normal but if it were to fail, the severeness of it would be shown in the sense that no data would be retrieved through the scout. Both scouts are configured on the SSBACAM server. This server is used as the main asset management server for the total asset management solution for the Solvents site.
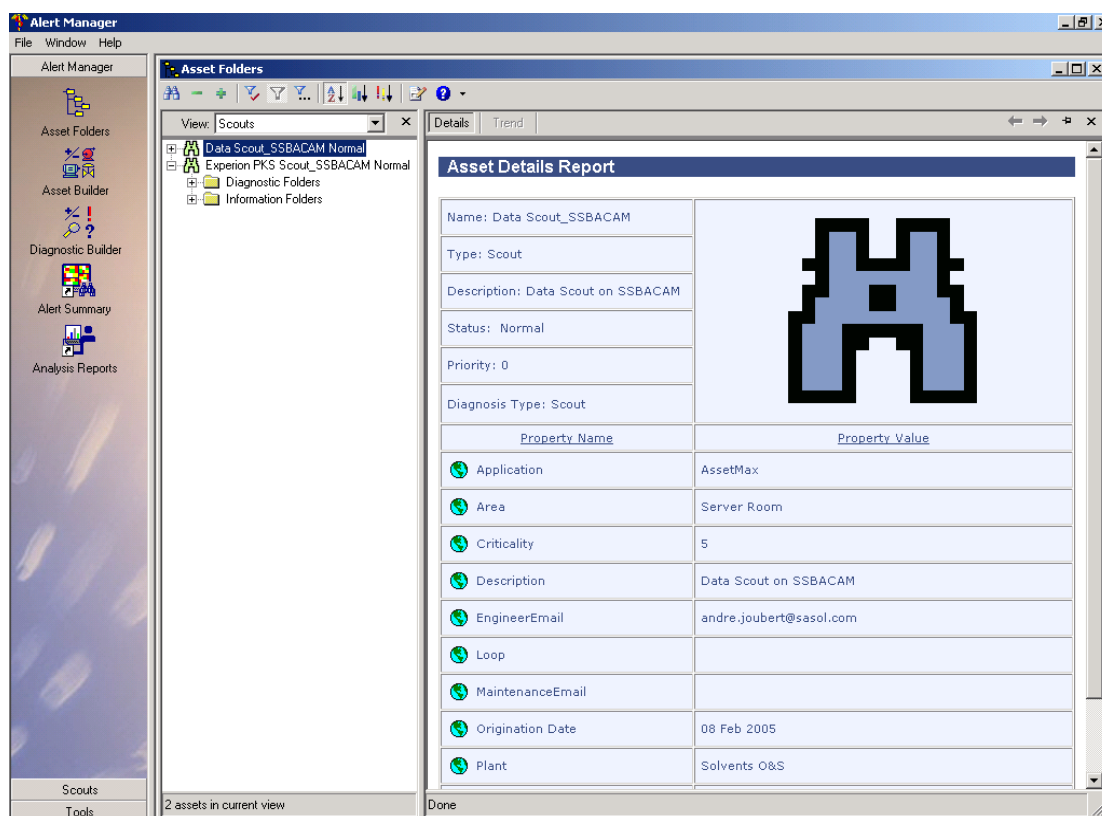

Figure 54: Scouts view

5.7.12 Data Sources

The data sources are the different OPC interfaces to the different OPC servers. Figure 55 shows the different data sources connected to the four Honeywell OPC servers and the PHD OPC server. The OPC servers used on the Honeywell DCS are the HWHsc.OPCServer. When third party software needs to retrieve or access data from these DCS systems, the OPC client from the third party software must interface to this HWHsc.OPCServer on the DCS.

These OPC interfaces are monitored to ensure that all the data needed from these systems is functional. Symptoms and fault trees are configured for these interfaces. All the associated asset information for the data sources is configured. This can be seen in figure 55.
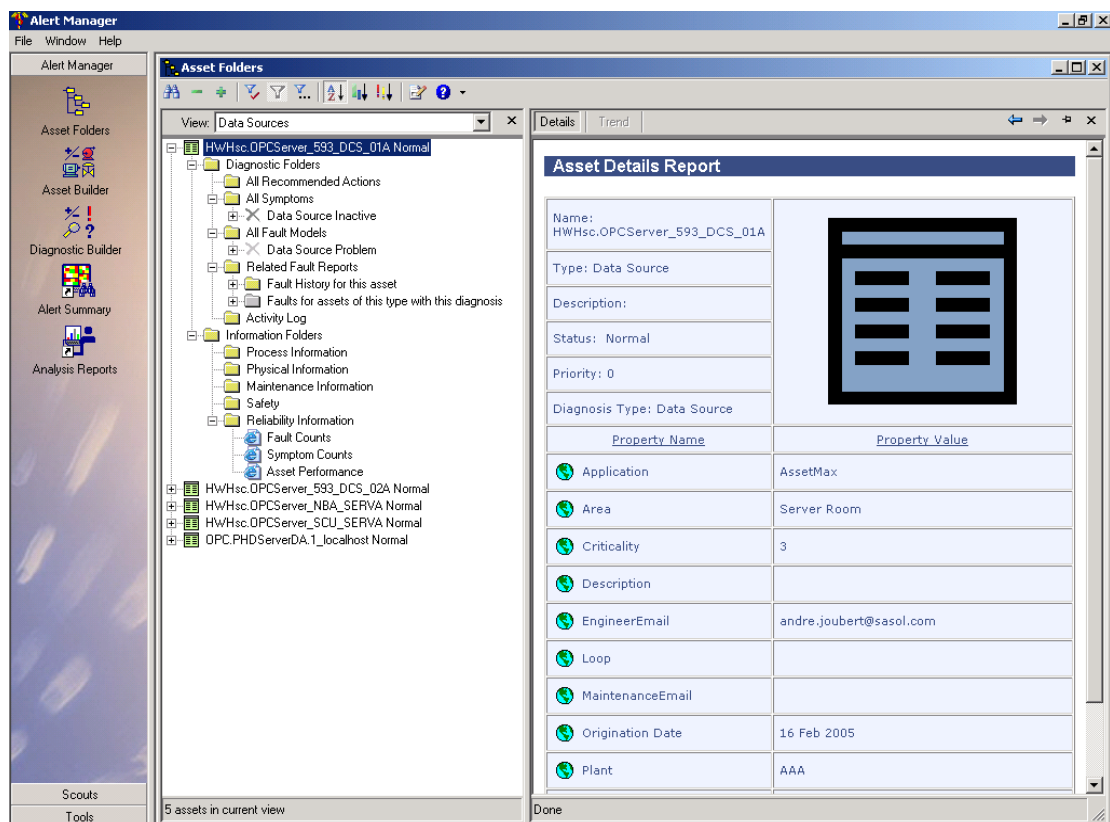

Figure 55: Data sources view

5.7.13 Experion Areas

Within the PlantScape DCS, certain processes, equipment or plants are configured according to specified areas. These areas are not linked to a specific plant area as previously discussed. Experion areas address certain alarms philosophies such as what alarms must be activated for what process or equipment such as a compressor, different views to operators and views to other plants using distributed system architecture (DSA) configurations.

Figure 56 shows the equipment in the Experion areas and non-Experion areas. PlantScape hardware associated with the Experion area is configured in such a way that the equipment generating alarms can be viewed to ensure that they are on line and healthy. In figure 56, Area D41 shows the three C200 controllers that controls that specific area of the process. The non-Experion areas are the areas that are not associated with PlantScape hardware.
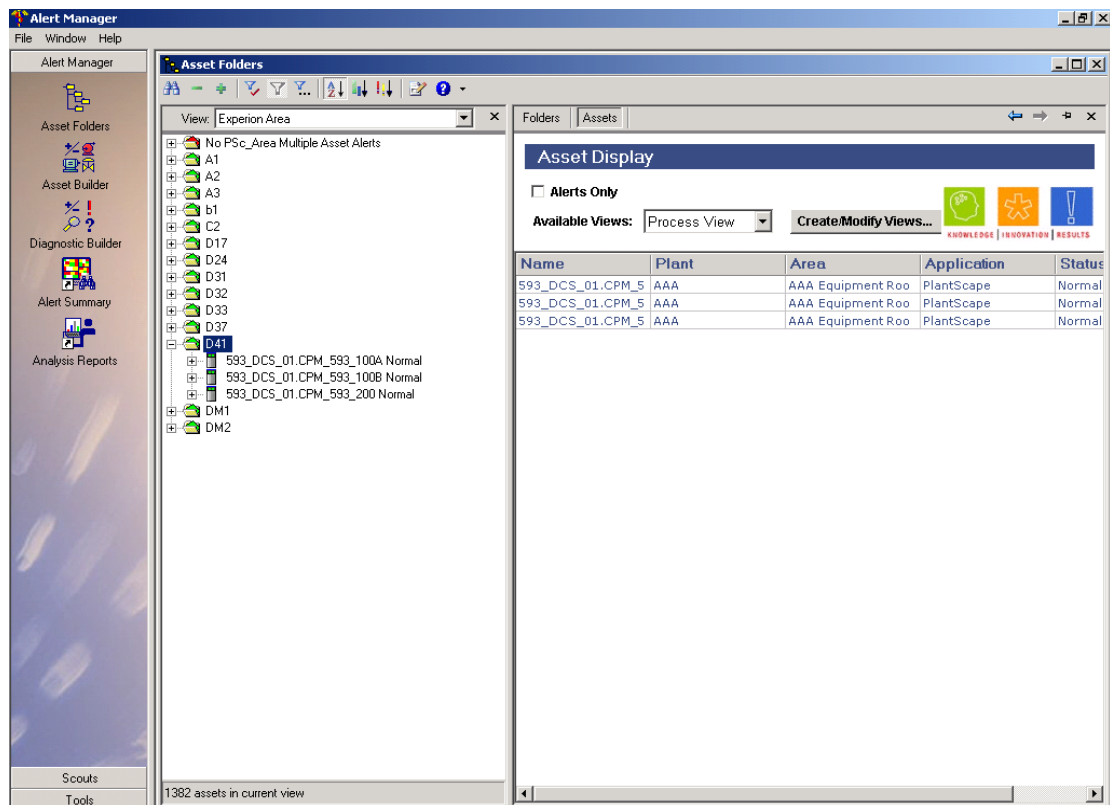

Figure 56: Experion area view

5.7.14 Out of Service View

During shutdown periods it is required to do certain maintenance actions on field devices. When this device is removed from the plant to be cleaned or fixed it is necessary to take this device out of service on the AlertManager. If the device is removed the scouts would pick up that the device is not present in the system and it will start reporting alerts for this device. This would then influence the history data and activity logs. Taking the device out of service before disconnecting it ensures that no false alarms are reported for this device. It is also part of the maintenance process to check that all removed equipment is placed back in the plant and put back into service once the maintenance of such is complete. This view shows what devices are still not put back into service. This example shows a pressure transmitter that is still out of service. At the bottom of the view it indicates how many assets are out of service.
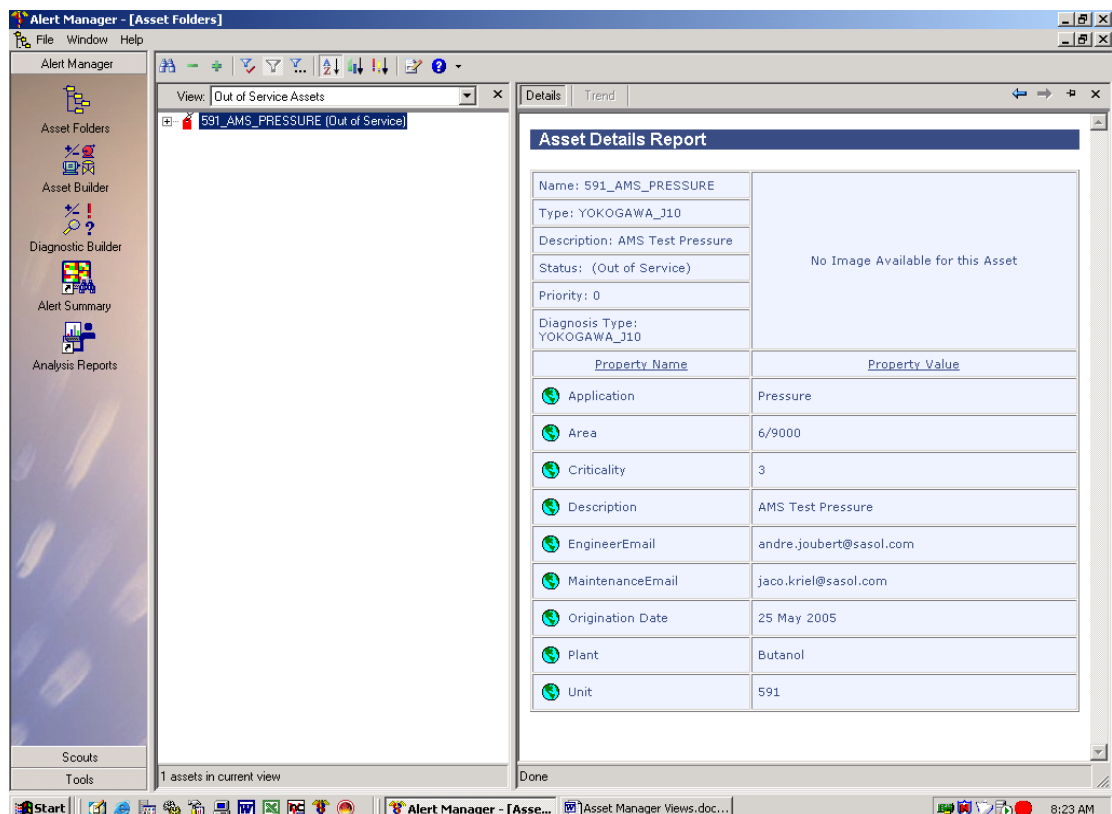

Figure 57: Out of service asset view

120

5.8   Conclusion

In this chapter asset healthcare of the different field devices and systems were discussed. The developed interfaces and the way they interface to the different systems were reviewed and the views of the configured equipment and systems in the AlertManager were shown and discussed. Asset healthcare information from the different systems discussed in the chapter will be used in the maintenance strategies that is developed and rolled out. In chapter 6 the equipment history block from the SAMI model in stage two will be shown and discussed. The way history is presented and how it will be used in the maintenance strategies will also be discussed.