

Networking and Centralized Monitoring Station of Pot Tending Assembly

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Abstract

Availability and reliability of Pot Tending Machine or Assembly (PTM or PTA) is one of the key deciding factors of potline performance of any aluminium smelter. In the earlier generation design, without maintenance bay and gantry system, maintenance of PTM was a challenging job. The reliability of PTA plays a very vital role in on-time completion of operational activities like anode change, beam raising, pot preparation, etc. As the PTAs are not a stationary equipment, even predictive maintenance is very difficult. The objective of this paper is to demonstrate centralized monitoring station of PTA which is featured by wireless communication and networking of all PTAs. The networking is designed with wireless modules installed in individual PTMs, Unshielded Twisted Pair (UTP) cable, fibre optic link and various converter switches. All PTAs are connected to a centralized monitoring station where online simulation of every tool and its operation are visualized via SCADA server, real time access of PLC programming via engineering server, data backup, real time motor current, temperature trends and fault logging via historian server and automatic messaging system for fault generation. The implementation of this concept shows reduction in Mean Time To Repair (MTTR), manpower optimization, betterment in predictive maintenance and steady improvement in availability and reliability of PTAs.

Keywords: Pot Tending Assembly PTA, Predictive maintenance, SCADA, MTTR, Trends, Wireless communication.

1. Overview of Project

With 2 Potlines and 608 running pots for production, PTM plays a vital role in hot metal production. Each Potline has 4 rooms with each room has 4 PTMs. So, total number of PTMs available in operation is 16. The paper highlights the networking of all 16 PTMs to one common station.

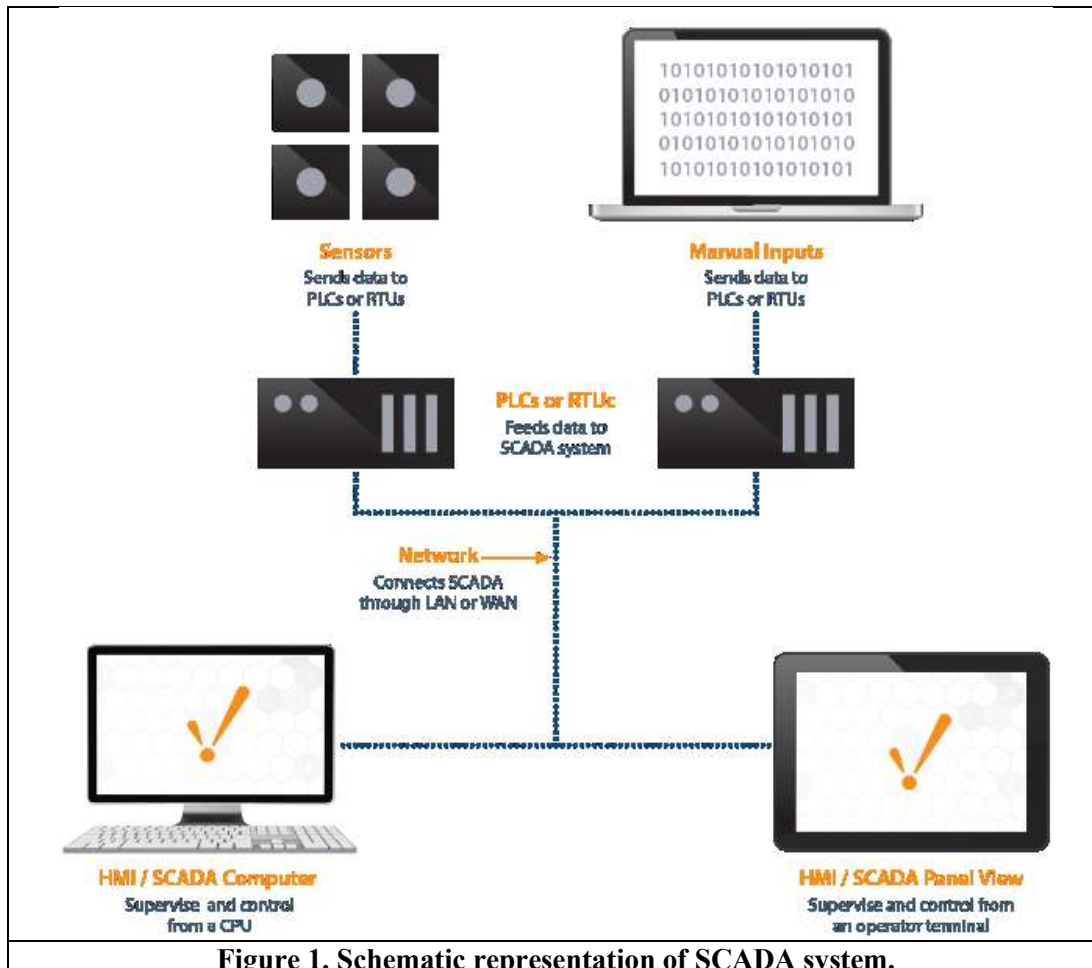
2. Introduction

Pot Tending Machine (PTM), which is a specialized overhead crane designed for aluminium smelter to carry out the operational activities like anode change, bath covering, beam rising etc. PTM is considered as one of the most critical equipment in potline as it directly facilitates in quality of pot performance and so the hot metal production.

3. SCADA – An Overview

SCADA systems (Figure 1) are used by industrial organizations and companies in the public and private sectors to control and maintain efficiency, distribute data for smarter decisions, and communicate system issues to help mitigate downtime. SCADA systems work well in many different types of enterprises because they can range from simple configurations to large, complex installations. Virtually anywhere you look in today's world, there is some type of SCADA system running behind the scenes. Effective SCADA systems can result in significant savings of time and money. Modern SCADA systems allow real-time data from the plant floor to be accessed from anywhere in the world. The introduction of modern IT standards and practices such as SQL and web-based applications into SCADA software has greatly improved the efficiency, security, productivity, and

reliability of SCADA systems. SCADA software that uses the power of SQL databases provides huge advantages over antiquated SCADA software. One big advantage of using SQL databases with a SCADA system is that it makes it easier to integrate into existing MES and ERP systems, allowing data to flow seamlessly through an entire organization. Historical data from a SCADA system can also be logged in a SQL database, which allows for easier data analysis through data trending.



4. Necessity of SCADA in PTM

As PTMs are not a static equipment, the following proactive activities are quite impossible/very difficult in reliability maintenance point of view:

- Monitoring of various parameters like current, temperature, pressure etc.,
- Alarm indication,
- Forecasting of machine failure,
- Online access to PLC program,
- Predictive maintenance.

5. PTM Networking – Entire Layout

The layout of PTM networking (Figures 2 and 3) consists of the following components:

- Moving wireless access point
- Static wireless access point
- Ethernet to FO converter module
- Local FO trans-receiver module
- Central switch
- Primary SCADA server
- Secondary SCADA server

- Engineering Station
- Historian
- GSM Module.

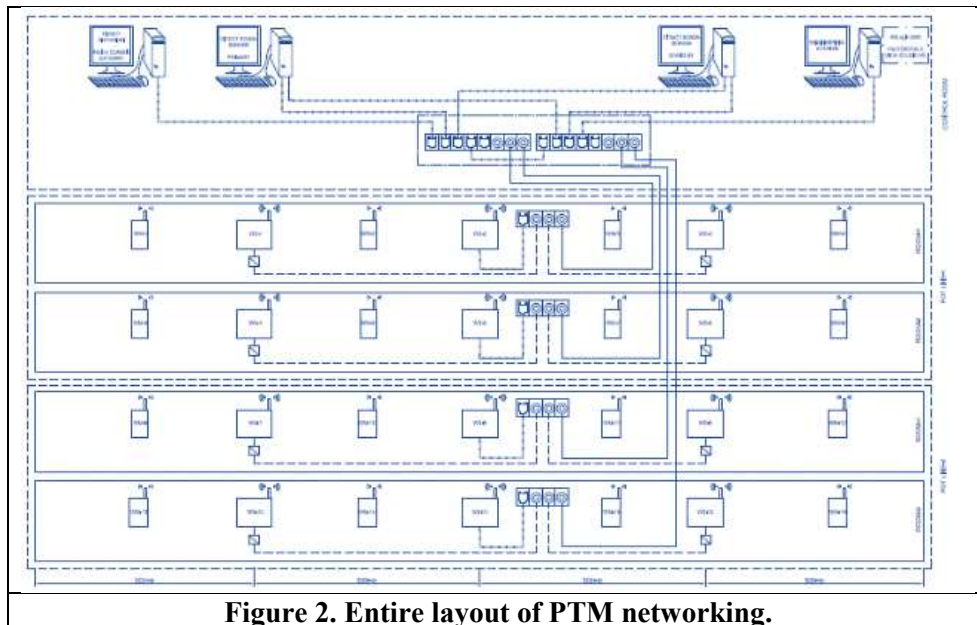


Figure 2. Entire layout of PTM networking.

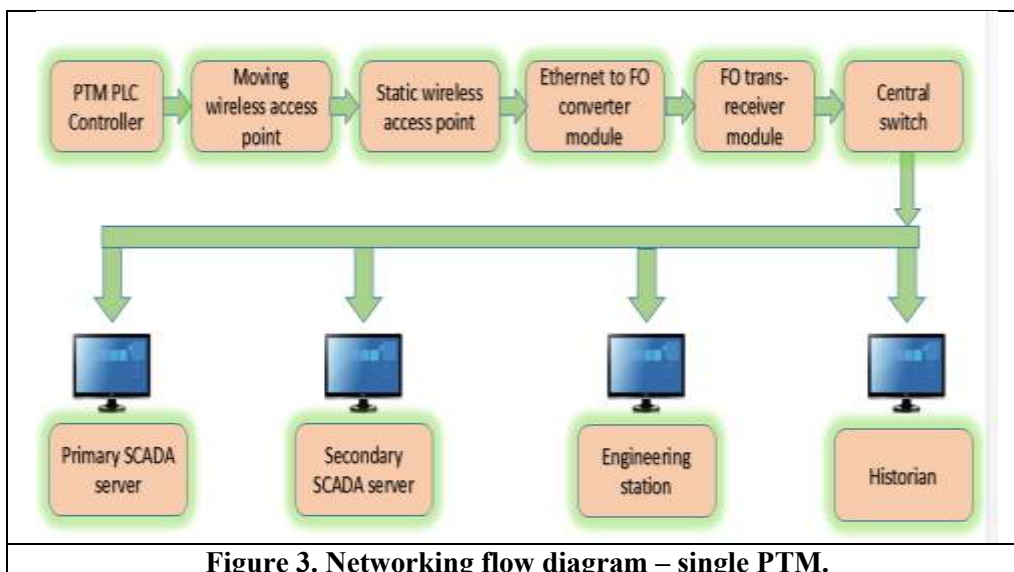
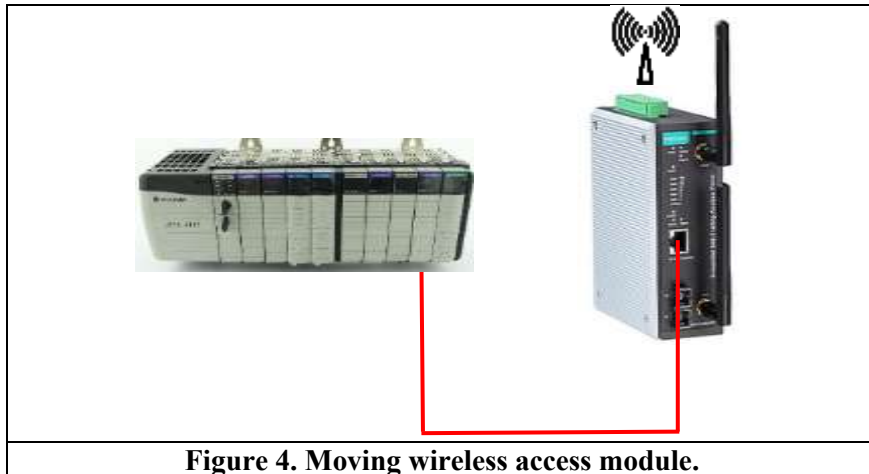


Figure 3. Networking flow diagram – single PTM.

5.1. Moving Wireless Access Point

This moving wireless access module is installed in individual PTM. As this wireless module is installed in moving PTM equipment, it is called as “moving wireless access point” (Figure 4).



The input to this wireless module is ethernet signal which comes from ENBT module of 1756-PLC controller. Through this mode of connection, all I/O's information of PLC controller of individual PTM is read by wireless module. The moving wireless access point is connected to an antenna for better and fast transmission of wireless signal to the nearest intermediate static wireless access point.

5.2. Static Wireless Access Point

The signal from moving wireless access point is connected to the nearest static wireless access point via wireless signal. To get better strength in wireless signal, the number of intermediate static wireless access points installed to cover the total span length of building which is about 4400 meters. This module is installed in the building structure.

5.3. Ethernet to FO Converter Module

The signal from static wireless access point is converted to fibre optic signal using "Ethernet to FO converter". Each static wireless access point is attached with an Ethernet to FO converter module.

5.4. Local FO Trans-receiver Module

All signals from FO converter module is bridged to the local FO trans-receiver module installed at site. The configuration of Local FO trans-receiver module is such that one per building is installed. The network layout shows there are total 4 no's of building in the system.

5.5. Central Switch

All the FO signals from local trans-receiver are connected to a common interfacing module named as Central switch. This central switch is installed in the central control room and redundant in nature.

5.6. Primary SCADA Server

This server is built up with citec coding along with pictorial representation of various tools, equipment's and functions of PTM. This server is read-only and written is not possible. This server enables:

- Real time monitoring of PTMs,
- Reading I/Os,
- Trend for various parameters like temperature, pressure, oil level etc.,
- Online current monitoring,
- Motor running hours display,
- History of various faults, and
- Data logging and report viewing.

5.6.1. Online Monitoring of PTM

All live movements of PTM can be monitoring from the central control room by Primary server (Figure 5). Mimic will show the direction of movement, location of PTM and all other activities carried out by PTM. This is just the clone of on field actions.



Figure 5. A view of online monitoring of PTM.

5.6.2. Live Status of PTM Communication Network

All nodes connected to the device-net network communication is visually displayed in primary server (Figure 6). Healthiness of I/O module, relay, and communication strength are able to monitor from control room. This will enable predictive maintenance in terms of network communication.

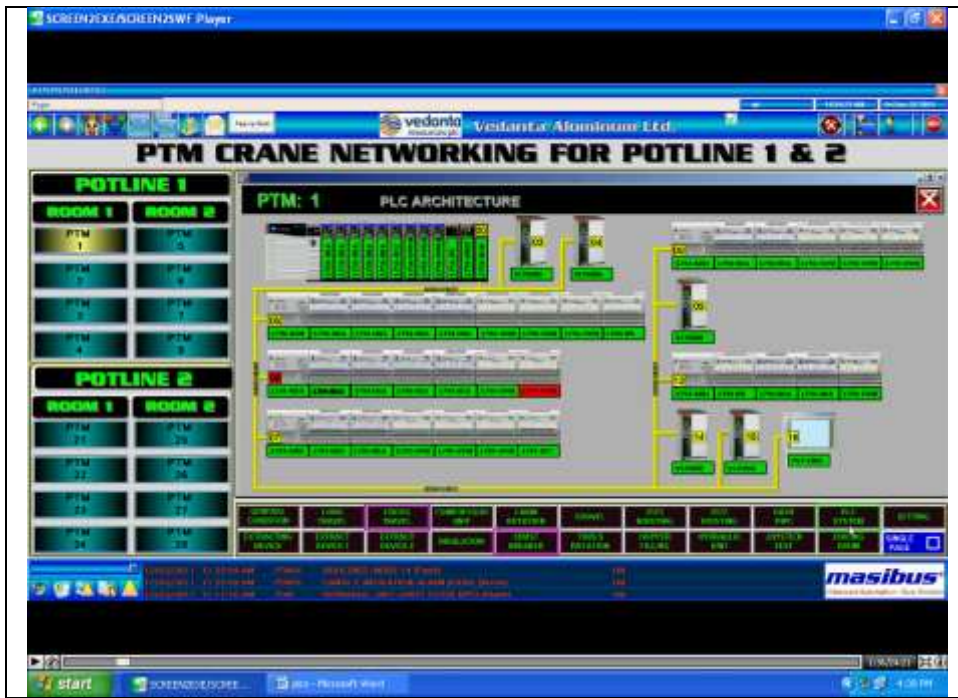


Figure 6. Visual Display in Primary Server.

5.6.3. Recommendation for Maintenance

Based on the running hours of critical equipment, its maintenance schedule is auto triggered. For example: based on the running hours of compressor unit, its routine maintenance activities like cleaning of drain filter, cleaning of inlet filters, cleaning of oil and air radiator, oil change, cleaning of oil return filter, replacement of oil return valves, oil filter, air/oil separating elements are auto triggered (Figure 7).

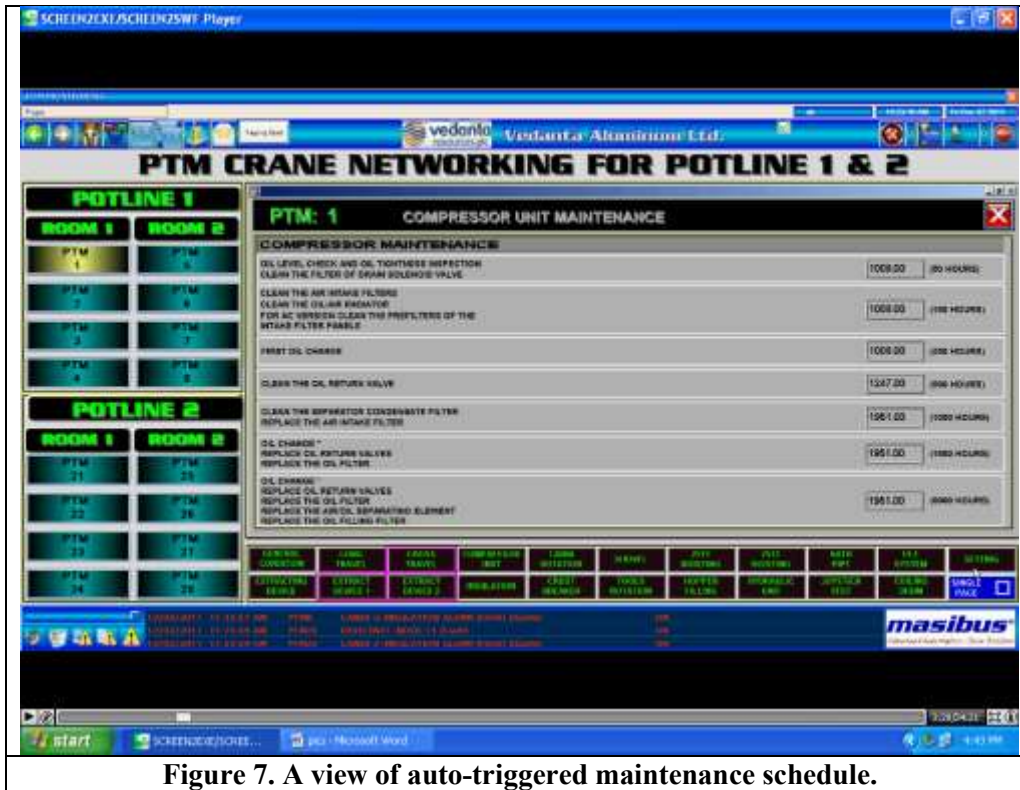


Figure 7. A view of auto-triggered maintenance schedule.

5.6.4. Recommendation for Motor Overhauling

Monitoring of motor running hours and motor current are available in primary server. This enables us to do proactive maintenance of motor overhauling based on:

- Motor running hours
- Motor current trend

In the programming, nominal current and maximum running hours of various motors ranging from 55 kW to 0.45 kW is logically programmed and based on the tolerance limit. Pop up will be enabled for motor overhauling (Figure 8).

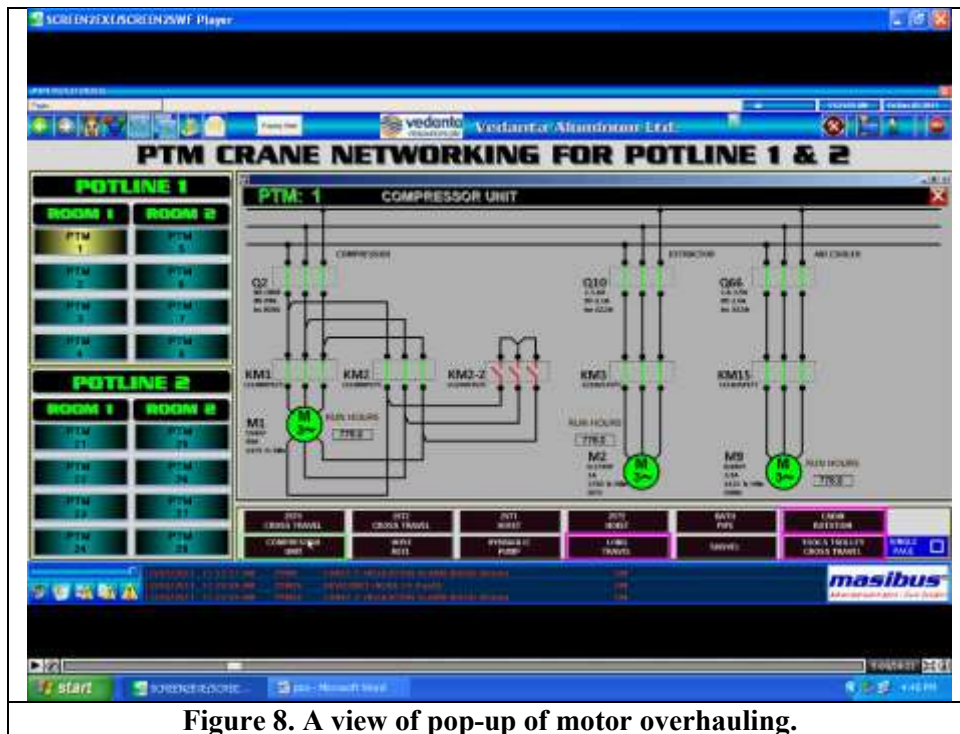


Figure 8. A view of pop-up of motor overhauling.

5.6.5. Monitoring of Hydraulic and Pneumatic Circuit

Mimic for hydraulic and pneumatic circuit is designed in primary server (Figure 9). This will enable to monitor the actuation and de-actuation of valves, cylinder along with the timing sequence. The following parameters shall be monitored from primary server:

- Acceleration and deceleration of hydraulic cylinder.
- Flow and pressure of hydraulic tools and its cylinder.
- Differentiate the energized pressure line from tank line and holding pressure line.
- Positioning of pressure switch, retain valve, and silencer.

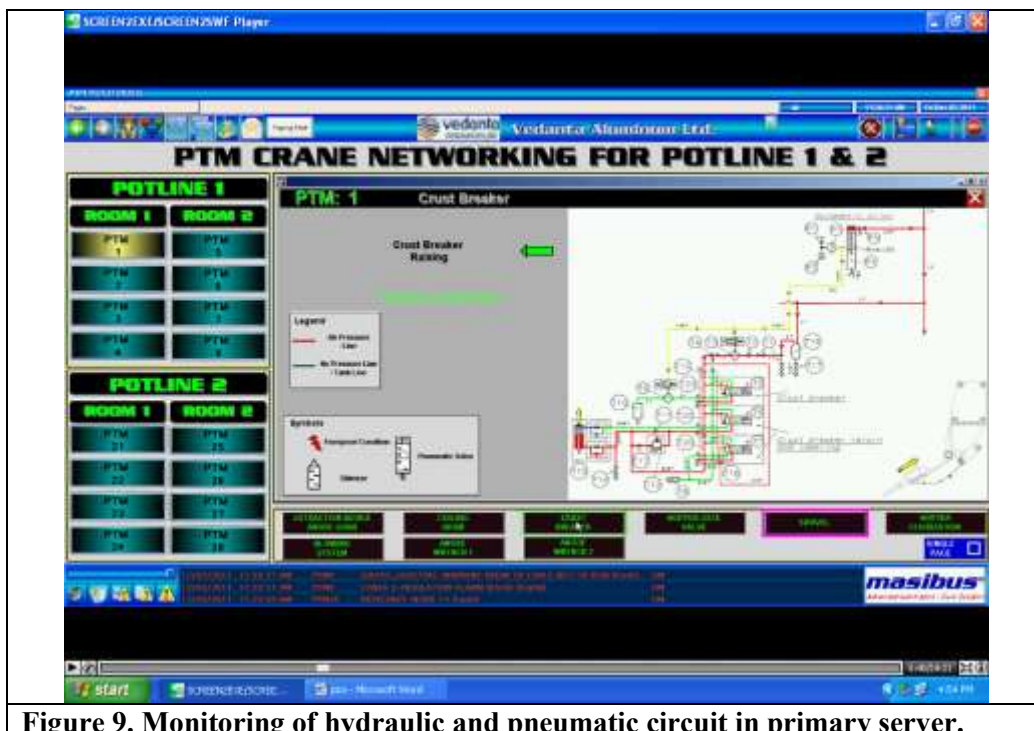


Figure 9. Monitoring of hydraulic and pneumatic circuit in primary server.

5.6.6. Trend Analysis of Critical Parameters

Critical parameters like compressor oil temperature, hydraulic oil temperature, outlet pressure and motor running current are designed to view in line graph. This will enable us to review the performance of critical parameters for a period of last 2 months. Parameter analysis and interpretation of fault occurrence are very easily (Figure 10).

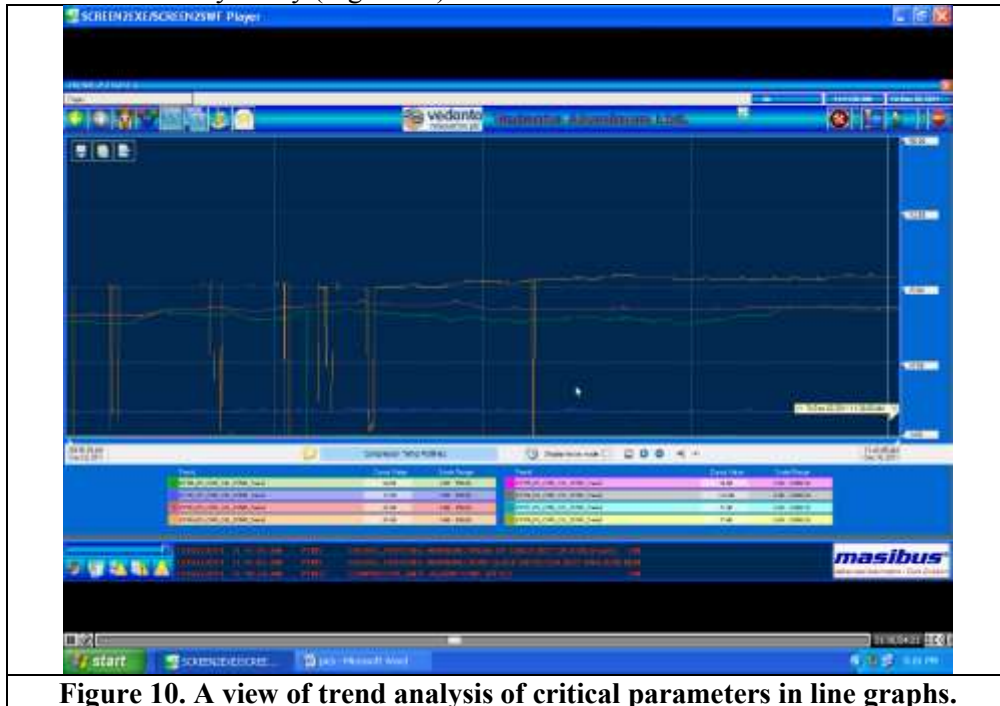


Figure 10. A view of trend analysis of critical parameters in line graphs.

5.6.7. Alarm/Fault Popup and Logging

Fault or alarm in any PTM will be popup on the primary server screen and accordingly action will be taken up immediately. Apart from popup, data log for the last one year is made available in the server which will enable us for deep and detailed analysis on occurrence of various faults and alarms (Figure 11). Alarm popup is very vital in performing predictive maintenance. For example, if compressor oil filter change is scheduled after 2000 hrs of running, then this alarm screen will pop up an alarm at 1950 h as an indication for filter change.



Figure 11. A view of alarm/fault pop-up on server screen.

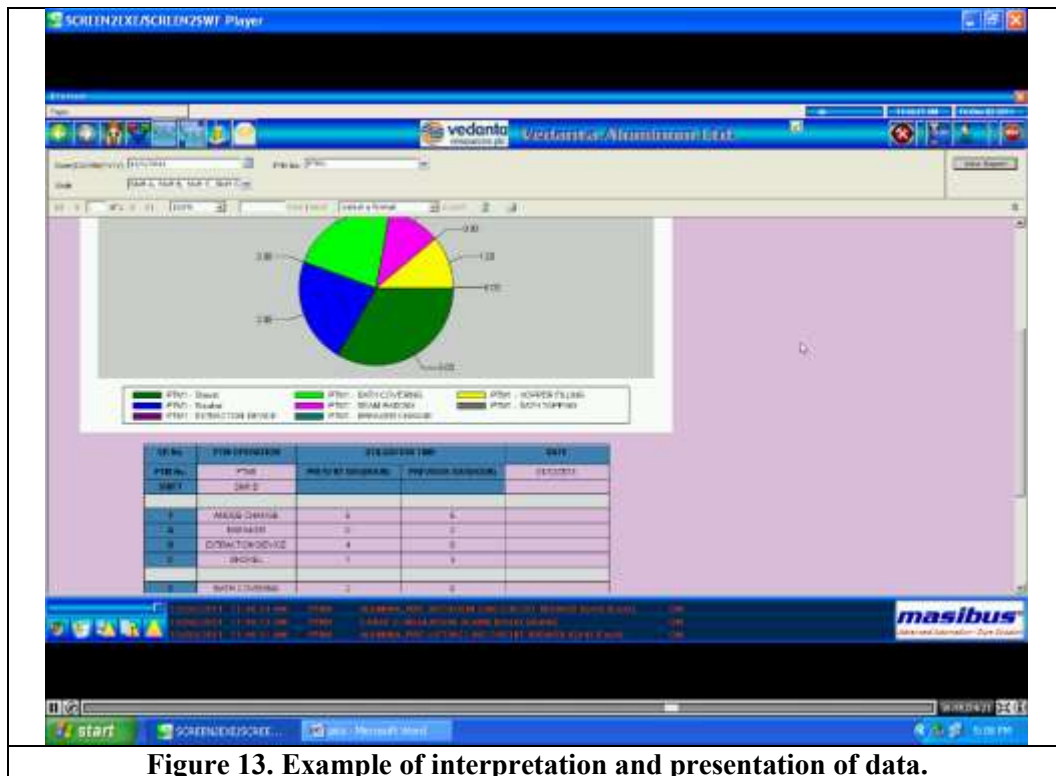


Figure 13. Example of interpretation and presentation of data.

5.7. Secondary SCADA Server

Secondary SCADA server system act as the redundant system for primary SCADA server. Normally secondary server will be kept in sleep down and will be in action when primary server is turned off for routine maintenance.

5.8. Engineering Station

Engineering station is the master brain for PTM networking system. All I/Os from PTM are read by RS Linx Gateway installed in engineering station. The primary server and secondary server fetch the data of PTM from the live tags on engineering station. Engineering station. The various software build in engineering station are:

- RS Linx Classic Gateway.
- RSLogix5000.
- RSNetworkx.
- FTView Studio Machine Edition.

The purposes of engineering station are:

- Online access of programming,
- Ease in programming,
- Ease in Panel vie configuration,
- Quick configuration of device-net network, and
- I/O fetching for primary and secondary server.

5.9. Historian

A Data Historian (also known as a Process Historian or Operational Historian) is a software program that records and retrieves production and process data by time; it stores the information in a time series database that can efficiently store data with minimal disk space and fast retrieval. Historian is the data manager for entire PTM networking system.

5.10. GSM Module

GSM is a mobile communication modem; it stands for global system for mobile communication (GSM). A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates. GSM module is connected to the Primary server station. Critical faults are listed and programmed in primary server station. If such critical fault got triggered, automatic SMS will be delivered to the defined members using this GSM module.

6. Benefits of PTM Networking

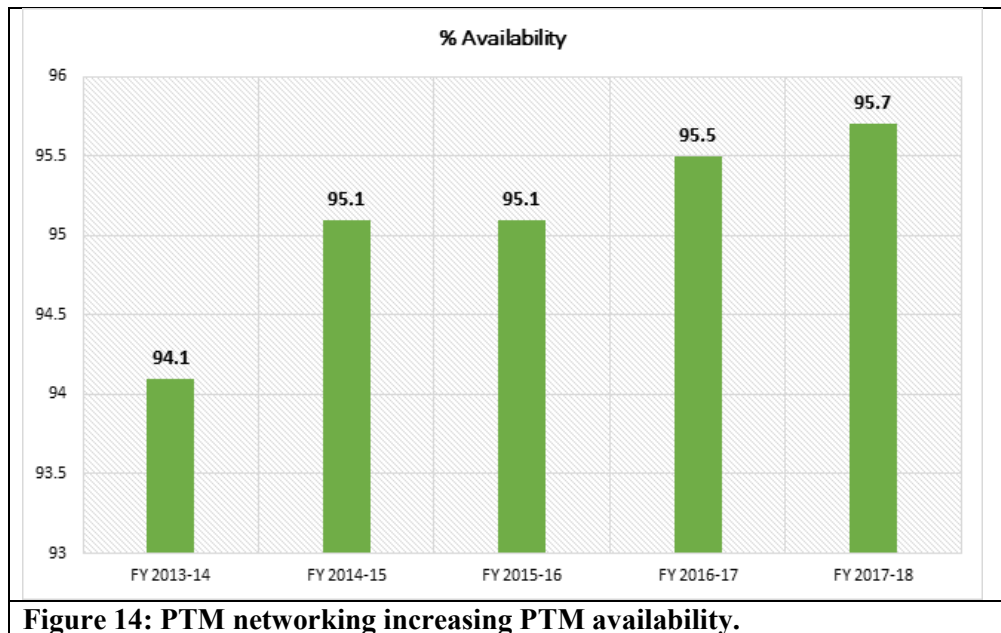
The benefits of PTM networking are shown in Table-1.

Table-1. Benefits of PTM networking.			
SITUATION	PARAMETERS	BEFORE	AFTER
NETWORK RELATED FAULTS	<i>TROUBLESHOOTING</i>	Difficult	Easy
	<i>MANHOUR</i>	3 hrs(AVG)	1 hr
	<i>MANPOWER</i>	3 (Minimum)	2
PROGRAMME ACCESS/EDITING	<i>MANHOUR</i>	1 hr 30 min	20 min
	<i>MANPOWER</i>	2	1
	<i>EASE OF ACCESS</i>	Difficult	Easy
	<i>PTM UTILIZATION</i>	Operation interrupted in both accessing & editing	For accessing : Operation not interrupted. For editing : Operation interrupted only for 5 mins
DRIVE DRIVEN MOTOR LOAD MONITOIRING	<i>MANHOUR</i>	30 min	5 min
	<i>MANPOWER</i>	2	1
	<i>EASE OF ACCESS</i>	Difficult	Easy
	<i>PTM UTILIZATION</i>	Operation interrupted	Operation not interrupted
FAULT DETECTION	<i>MANHOUR</i>	30 min	5 min
	<i>MANPOWER</i>	2	1
	<i>EASE OF ACCESS</i>	Difficult	Easy
	<i>SAFETY</i>	Accessing panel view is difficult (while operating from remote)	Easy
PTM HEALTH MONITORING	<i>MTBF/MTTR CALCULATION</i>	Manual calculation	System generated
	<i>REPETITIVE BREAKDOWNS</i>	Manual logbook	System generated
	<i>MOTOR RUNNING HOURS</i>	NA	Available & so predictive maintenance is enabled

7. Deliverables of PTM networking

- MTTR reduction,
- Increase in PTM availability, and
- Enhanced safety performance.

Not only the PTM networking enable us in MTTR reduction and PTM availability increase (Figure 14), but however PTM networking play a vital role in both maintenance parameters.



8. Conclusion

PTM networking system plays a major role in achieving the maintenance parameters. Without maintenance bay and gantry system, the reliability of PTA was really a big challenge for production unit. Networking of PTM enable us for predictive maintenance, ease of data analysis, equipment overhauling scheduling, ease in fault finding and so the reliability of entire equipment. The equipment availability increased from 92 % to 95.7 %. Any modification needs a change in programme logic, which is not an easy opportunity. PTM networking enables us to modify the programs as per various improvement project requirements and user necessities. The life changed from the mind-set of “Run to Failure” to “Predictive Maintenance”.