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Application of Wireless Instrumentation in Heavy Power Plant

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ABSTRACT: This paper deals with the idea of implementation of Wireless Technology in heavy equipment power plant. Wireless Technology being the latest, and, wireless networking and instrumentation, being the fastest and modern technology for communication, results in reduced installation time and lower installation costs, and proves to be an asset over wired one in many aspects in the area of engineering.

KEYWORDS: Wireless, instrumentation, networks, communication, engineering.

1. INTRODUCTION

Heavy power plants are generally engaged in the design, engineering, manufacturing, construction, testing, commissioning and servicing of a wide range of products and services for the core sectors of the economy, i.e. power, transmission, industry, transportation, energy, oil and gas and defense. In these type of power plants, control and instrumentation are the two important tools for measuring, monitoring, processing and controlling any collected information, or data, in a project.
Wired devices, or say, wired connection has many disadvantages. For example, to facilitate installation of these devices, arrangements for laying of cables have to be necessarily made, i.e. doing cable erection work. This is a labor intensive and time consuming. Also, any new devices added in future into an application, would involve same cabling hassles. Any harsh emergencies such as incidents of fire, water logging etc shall result in mess and redoing all work. In cases of any cable faults, identification of faulty cable, determination of faulty point and its further rectification is a mammoth task. Advantages of wireless instrumentation over a wired one is:-

1) Reduced installation time resulting in lower installation costs.
2) Increased device and process information resulting in improved maintenance practices.
3) Easy to rectify problems, as cable hassles will not be there.

II. THEORETICAL BACKGROUND

Wireless network refers to any type of computer network that is not connected by cables of any kind. It is a method by which homes, telecommunications networks and enterprise (business) installations avoid the costly process of introducing cables into a building, or as a connection between various equipment locations. It is done with the help of Radio waves. A **Wireless Sensor Network** (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, humidity, motion or pollutants and to cooperatively pass their data through the network to a main location. It is employed in industrial process monitoring, industrial automation and control, machine health monitoring, military applications, and so on. Wireless networking has become a quick, easy and economical alternative to running wires around our homes or offices. It has opened up

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possibilities for connecting buildings which are up to several kilometers apart. There are various standards upon which wireless networking devices are built, for example, WIRELESS HART and ISA100.11. They depend upon better obstacle penetration and scatter making them superior for non-line-of-site propagation.
In heavy power plants, which are used to generate electricity and power, an instrumentation system, or, control system exists. A Distributed Control System (DCS) aims to control widely dispersed plant. The distribution of control also necessitates distribution of instrumentation (sensors and actuators).

Instrumentation is carried out by instruments like pressure, temperature sensors. In addition to these, instruments like seal steam isolation valve, bypass valve, vapor exhauster, vacuum breaker, faults alarm etc are also installed. These instruments are helpful in providing time to time reading, monitoring, measuring and maintaining accuracy of machine data. But along with these all, there are certain disadvantage of using wireless instruments too. For example, in power plant like BHEL, tripping and controlling happens. Here, tripping means safety shutdown in case of emergency faults and controlling means, just in case if any instruments fails, then how transferring of data through other instruments takes place. In these two areas, wireless devices are not of much importance. Wireless devices and networks are used in case of monitoring of operations and time-to-time data updates through turbines/generators.

The wireless instruments, each battery can be arranged in two topologies:
1. **Star topology:** It is a point to point or line-of-sight architecture where individual devices or nodes, communicate directly with a gateway. In star topology, each device/instrument is located within the maximum line of sight distance from gateway and is followed by a repeater in case of distance exceeds.
*Note:- Gateway can be housed in control room with it's antenna at a convenient location preferably outdoors.

2. **Mesh topology:** It is a topology in which wireless devices can also communicate with either nodes in the network (point to multipoint) using a capability called multi-hopping.
The mesh topology provides the advantage of self organizing network. This network provides multiple path between each device and gateway. Also, as the network automatically finds the path, it is energy sufficient.

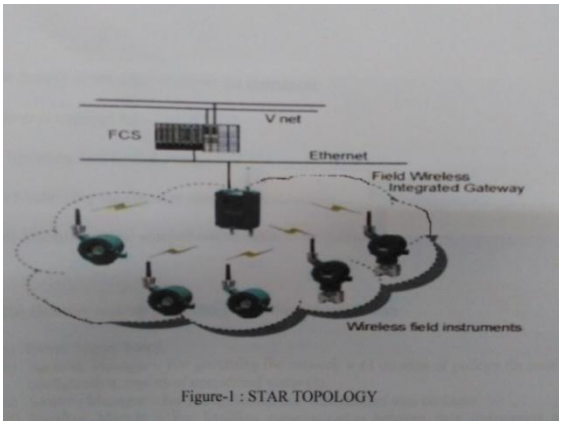

Figure 1: Star Toplogy

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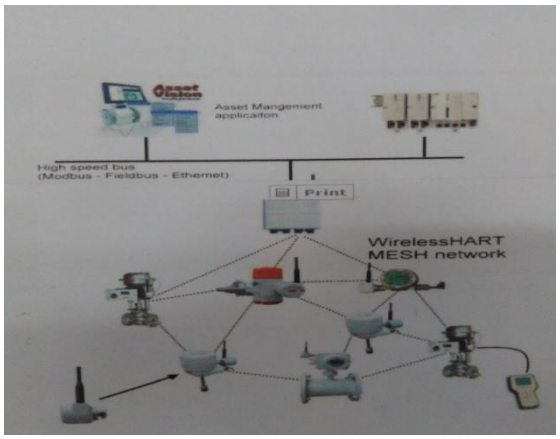

Figure 2: Mesh Topology

The battery is provided to power the instrument. Power is required for-
1) Updating the data from the sensor.
2) Modulating the signal to obtain desirable output.
3) Transmitting the wireless output signal to the gateway.

The gateway consists of primarily of the following components:-
a) Power supply board.
b)Network Manager:- For governing the network wrt creation of policies for runtime configuration, reports of operational status etc.
c) Security Manager:- For authentication and validation of data packages.
d)Interface Module:- For handling communication between field instruments and information systems.
The Gateway should be capable of authentication, verification, anti-jamming and encryption.

III. OBSERVATIONS

A research study was carried out during commissioning of wireless instruments. In general, pressure and temperature instruments and they are mounted to the auxiliary system of turbines/generators.

Normally most pressure instruments are connected to main pipeline through impulse line via isolation valves. So, for wireless PT, no separate tapping was made on the main line, but on the same impulse line via isolation valves for wireless PT had to be arranged separately at site. The temperature elements such as RTD's and TC's are directly mounted on pipelines. Normally, one of the elements such as RTD is connected to DCS through Junction Box (JB). The second element, if space, is wired up to JB. The terminations from the other end of JB are taken to Temperature Transmitter (TT).

Observation 1: The site was not completely ready. The wireless PT's had been mounted but electrical wiring of RTD's and TC's up to JB's had not been done. That is, site is ready with respect to erection of wireless items and completion of electrical wiring is a pre-requisite for commissioning of wireless.

a) The IP address of Gateway was made in line with IP address of DCS. All the wireless instruments were configured to wireless gateway. Update rate of Instruments was selected at either 16 sec or 32sec. The antenna and temperature transmitters (TT's) had not been mounted on the exact location, but kept on a table in control room in temporary wired stage. Communication between wireless gateway to PC was established through Ethernet ports on gateway via existing Ethernet witch. The measured values of the transmitters were obtained on PC and connection of 100% path stability was achieved**.**

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Observation 2: The mesh network had been disturbed due to relocation of wireless devices.

b) While integrating the wireless parameters on DCS, direct communication between gateway and PC was established through serial ports and gateway (i.e. MODBUS serial communication). Subsequently, the serial port on gateway is RS485 and the port on PC is RS232.
Observation 3: The feature of linking the third party system should be available in existing DCS. However "Bad data" prompt was appearing and integration of wireless data onto DCS could not be achieved.

c) Wireless data transfer was through 16 bits and next 16 bits were empty. However, data displayed on DCS is of 32 bits. The data was modified in DCS configuration software. With this, it was possible to obtain wireless values onto DCS in tabular column. 100% path stability and response was established. Also, RFI(Radio Frequency Interference) was noticed which was of -85dBm, normally the strength varies from -20dbm to -90dbm. This created the doubt that noise may not be due tot obstacles but due to cable fault.
Observation 4: The mounting of antenna is a very delicate task and should be done completely in vendor's presence.

IV. RESULTS AND FINDINGS

Parameters like seal oil temperature, cooling water temperature, gas temperature and pressure were observed with wireless instrument. And on comparison with DCS Data, there is a slight change in wireless readings, which means that instead of wired devices, wireless can be employed to a certain extent of turbines/generators.(Fig 3).

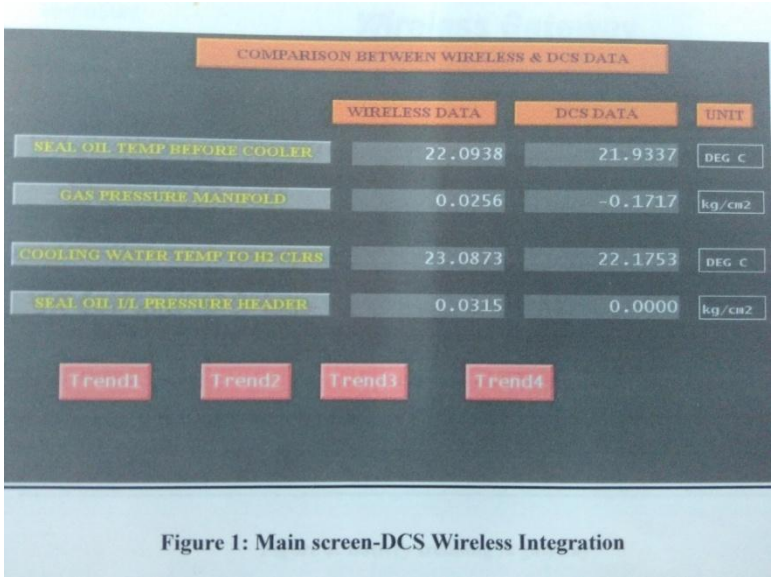

Figure 1: Main screen-DCS Wireless Integration

Figure 3: Main Screen-DCS Wireless Integration.

On observing wireless main screen, details about various equipment, like auxiliary carry water tanks, generators can be seen. Presence of how may devices are nearby the equipment can be observed. Also, the no. of updated can be measured.(Fig 4).

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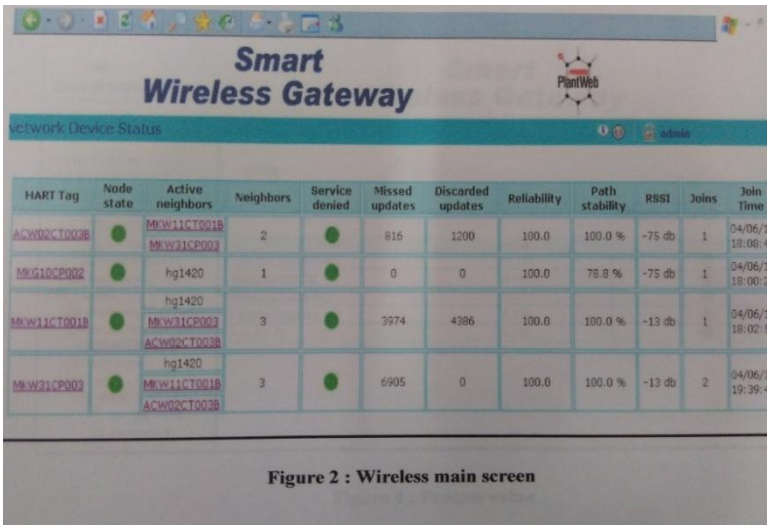

Figure 4: Wireless Main Screen

When at variation of temperature and pressure with respect to time is observed, battery trend can also be seen. Quick point data of these equipments can be observed.(Fig 5).

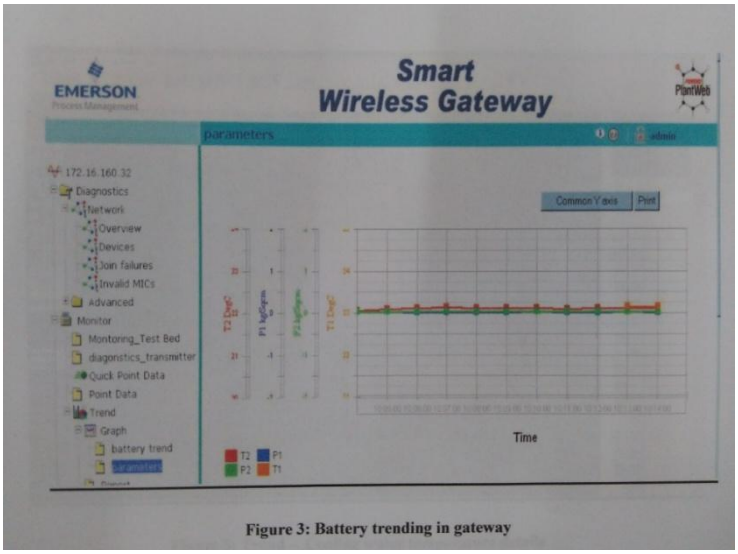

Figure 5: Trending at various parameters.

Trending at different temperature can be seen (Fig 6).

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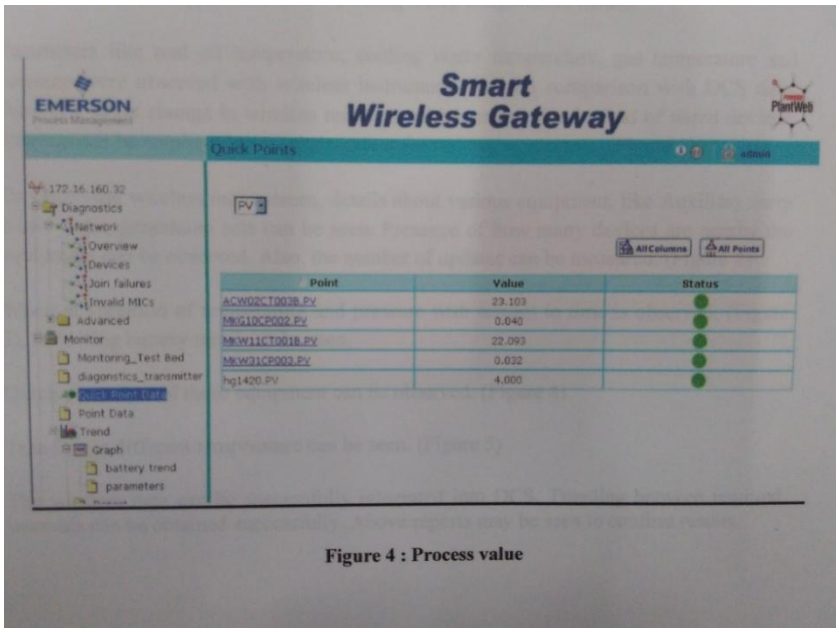

Figure 4 : Process value

Figure 6: Process Value

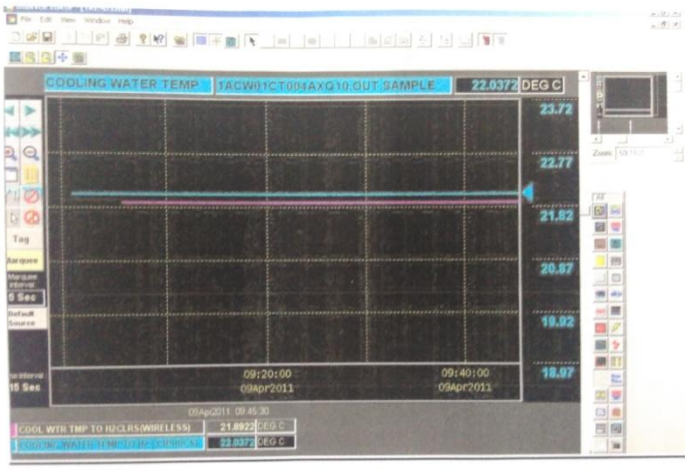

Figure 5: Trend – Cooling water temperature details

Figure 7: Cooling water temperature details.

The wireless data can be successfully integrated into DCS. Trending between required intervals can be obtained successfully.

V. CONCLUSION

Research study has been carried out and application of wireless networking and instrumentation has been discussed in this paper, along with the results and findings.

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