Integration of Wireless Hart Into DCS For Asset Monitor Applications

Vinay.G.R, B.Yogesha, G N Reddy

Abstract*— *With new firmware upgrade of wireless adapter, wireless HART is ready to redefine process monitoring, preventive maintenance and asset management. It enables users to quickly and easily gain the benefits of wireless technology while maintaining compatibility with the existing HART devices and tools. Wireless HART is designed with strict timing requirements and to be highly reliable and interoperable while being easy to install and operate. This new firmware upgrade was done to strike a proper balance between, simplicity, battery-life and guaranteed real-time wireless communication. In this paper, we present the test suite developed to exercise the wireless HART devices. We discuss the architecture of the test suite, the reliability of the mesh network after firmware upgrade of the wireless adapter and integration of wireless HART into DCS.

Keywords*— *integration, asset management, interoperability

I. INTRODUCTION

Wireless technology has been regarded as a paradigm shifter in the process industry and has received extensive studies recently [1]. Wireless HART® technology is based on the IEEE standard 802.15.4, which serves as the basis for reliable wireless radio transmission and it is built upon the known and proven HART® protocol. In April 2010, Wireless HART® was approved by the International Electro-technical commission (IEC) unanimously, making it first wireless international standard as IEC 62591. It uses wireless mesh networking between field devices, as well as other innovations, to provide secure, reliable digital communications that can meet stringent requirements demanded by industrial applications [2]. Even though there are over more than 30 millions of HART devices installed worldwide, in most cases the valuable information they can provide is stranded in these devices. An estimated 85% of all installed all installed HART devices are not being accessed to deliver device diagnostics information with only one process variable data communicated via the 4 20mA analog signal. This is often due to the cost and the difficulty of accessing the HART information. Wireless HART technology complement rather than replace wired instrumentation, and plants will often have both operating side-by-side. It's backward compatibility, including the HART command structure and Device Description Language makes it easy to support both wired and wireless devices using the same tools. Wireless HART also goes beyond promising device "interchangeability" to provide true interoperability. The integration of wireless HART into DCS to access and monitor unused information stranded in the field devices and also to check the reliability of real time wireless communication is the objective of this project.

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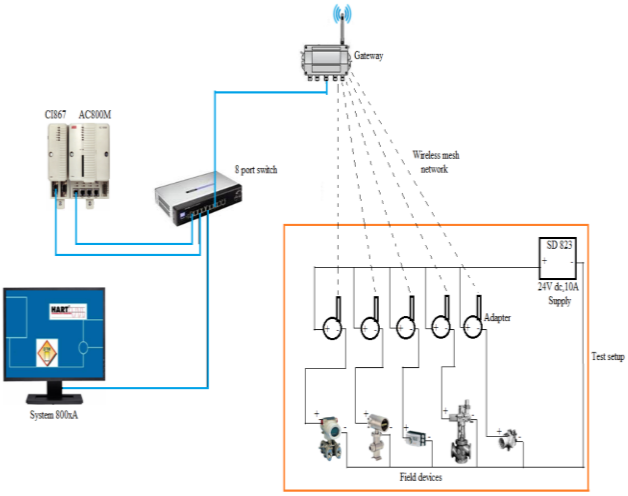

Fig 1: Architecture of the system

The architecture of the system is as shown in fig 1, this system consists of a controller (AC800M), a communication interface module (CI867), a wireless HART gateway (P+F), wireless adapters (ABB), 8 port switch (CISCO), a PC, a power supply module (SD 823) and field devices from different vendors. The portion shown in red color is the test rack. In this test suite there are 5 such racks placed at different distances from the gateway to check continuous communication of the field devices. Each such rack consists of adapters, field devices and power supply module.

A. Controller (AC800M)

It can be defined as a hardware platform to which individual hardware units may be connected and which, depending on the specific unit configuration, can be programmed to perform multiple functions. Once configured, the AC800M hardware platform effectively becomes the AC800M controller. To provide the controller with control software, it will be necessary to load the firmware and create application separately using Control Builder M engineering tool. The AC800M controller is designed to be a cost-effective; low maintenance solution for applications ranging from small Programmable Logic Controller (PLC) to advanced Distributed Control System (DCS) control applications and combined DCS and high integrity systems control applications.

B. Communication interface module (CI867)

CI867 integrates Modbus TCP/IP into AC800M system. Modbus TCP is an open industrial Ethernet network standard and request-response protocol that is widely used. It is a dual channel Ethernet module, one for 10/100 Base-T by the media independent interface and other for 10 Base-T by the 7-wires interface. It can be used to connect an AC800M controller to external Ethernet devices using Modbus TCP protocol.

C. Gateway (Pepperl+Fuchs)

It enables wireless HART devices to communicate with each other and manages network security and connectivity. The gateway device converts wireless device data to a format that is compatible with other systems. Gateway consists of 5 core elements: *Access point, Network manager, Security manager, Virtual gateway* and *Host interface.*

Access point: It is basically a radio which provides connectivity to the wireless HART network.

Network manager: It forms, organizes, monitors and extends the network. It takes care of distributing join key and network ID as well as communication slots and channels for all participants.

Security manager: It is responsible for generation, storage and management of the encryption and authorization needs.

Virtual gateway: It is the central component of wireless HART gateway. It distributes information to all other elements, caches data and provides access to the network manager.

Host interface: It forms connectivity to the wired world. It can consist of several physical interfaces like RS485 or Ethernet. Over these interfaces several protocols can be driven to gain flexible integration into host systems.

D. wireless HART adapter (ABB)

Wireless HART adapter plugs into an existing instrument, perhaps via an unused instrument connection port, or at a junction box, or other convenient location anywhere on the loop just like a handheld configurator. The wireless adapter will provide remote access to 8 available process variables within the instrument it is connected to.

E. 8 Port switch

The core purpose of this switch is to decongest the network flow to the workstation so that connections can transmit more effectively.

F. PC

A PC is used, in which, control builder M engineering tool, 800xA software is installed and is used to monitor the operations.

G. Power supply module (SD 823)

It provides 24V dc at 10A. This module is a switch-mode power supply unit converting main voltage to 24V dc, it doesn't require additional load-sharing control equipment.

H. Field devices

Different field devices from different vendors like pressure transmitters, temperature transmitters, corrosion transmitters etc.., are connected in the system.

II. BACKGROUND AND RELATED WORKS

Wireless HART has many similarities with other wireless standards, such as Bluetooth, Zigbee, Wi-Fi. But it differs itself from them in many other aspects. Generic wireless sensor networks are self-configurable and have no strict requirements on timing and communication reliability.

Wireless HART, ZigBee, Bluetooth operate in the same unrestricted 2.4GHz ISM radio band. Bluetooth support time slots and channel hopping, its communication range is just 10mts and supports only star type topology. It uses existing IEEE 802.15.4 MAC. In contrast, wireless HART supports mesh topology, thus providing better scalability and it defines its own MAC protocol [3]. It introduces channel hopping and channel blacklisting into MAC layer. Utmost reliability of the wireless HART network can be achieved by means of a meshed network where all nodes are able to route messages from the neighboring device efficiently providing an additional data path. Wireless instruments transmit data on a wireless channel back to the wireless gateway and, eventually, the host system. All transmissions are synchronized to avoid collision and loss of data [4]. Wireless HART employs a fixed time duration or time slot of 10ms for each transmission. Based on the update rate, these time slots are configured automatically to ensure that field devices send process data back to the gateway. The combination of frequency hopping and TDMA enables up to 1500 communications in the network per second. This is purely theoretical value; usually the net communication load should not exceed 30% or approximately 450 communications per second. A single wireless HART network can contain up to 250 devices. Taking the rule of 30 communications per second such a network could update all values about every 8 seconds. All the field devices connected in the network should update the process values continuously and shouldn't go offline.

III. IMPLEMENTATION

Implementation includes, connection of test setups, upgrading the wireless adapter with new firmware, configuration of network ID and join key, configuration of wireless HART in system 800xA, integration of wireless HART into DCS.

A. Test setups

In this we have utilized 23 ABB wireless adapters and 23 field devices from different vendors.

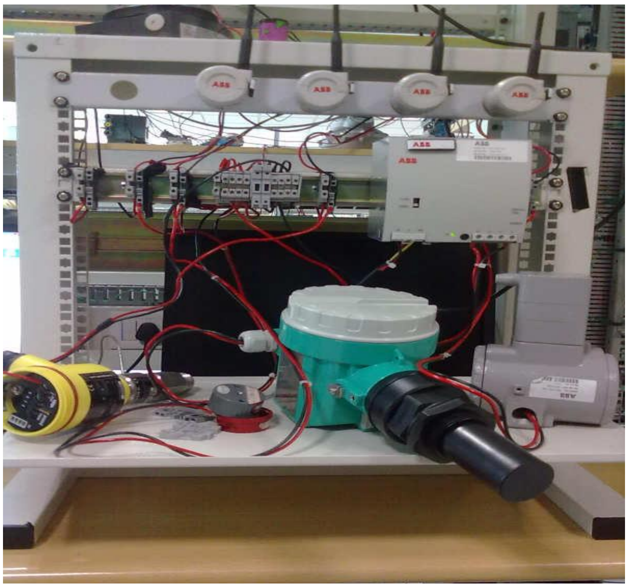

Fig 2: Test setup 1

This test setup or device rack consists of 4 ABB adapters and 4 field devices with 24V dc, 10 A power supply module. The field devices connected in this device rack are: LUC-M (Pepperl+Fuchs) is a compact measuring device for continuous non-contact level measurement, BAR 61 (VEGA) is a pressure transmitter, TP301 (Smar) is a smart transmitter for position measurement, MP82700H (S-products) is a microprocessor based temperature transmitter. Connection is done as shown in the below figure.

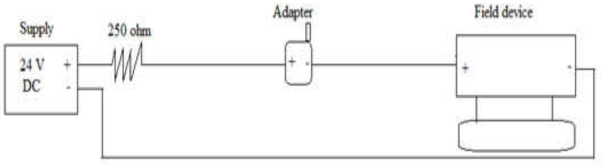

Fig 3: device connection to adapter

Test setup 2 consists of 5 ABB adapters, 5 field devices and power supply module. Field devices connected in this setup are: RTT15 (Foxboro), APR 2000 (APLISENS), CET (HONEYWELL), P 300 (Siemens), APT 3200 (AUTROL). Connection is done as shown in fig 3.

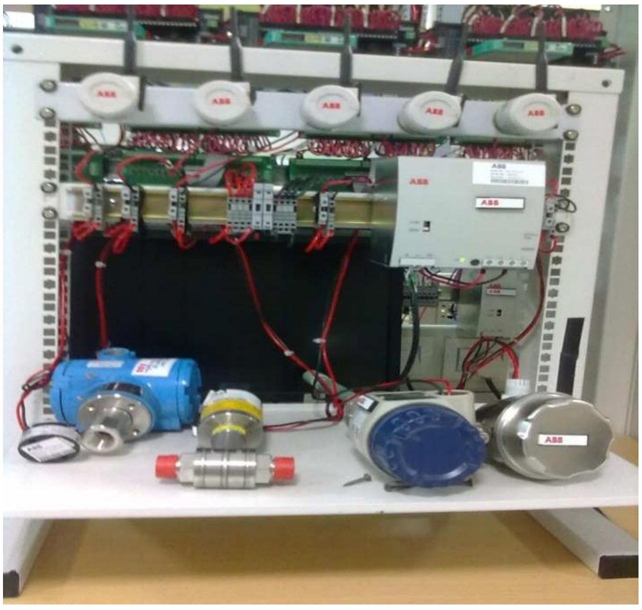

Fig 4: Test setup 2

Test setup 3 consists of 4 adapters, 4 field devices and power supply module. Field devices in this setup are: IDP 10 (Foxboro), TH 02 (ABB), P 300 (Siemens), T 32 (WIKA). Connection is done as shown in fig 3.

Test setup 4 consists of 5 adapters, 5 field devices and a power supply module. It is as shown in fig 5. The field devices connected in this setup are: 442 (Pyromation), MAG 805 (Magnetrol), MAG 704 (Magnetrol), 265 (ABB electronics), TP 301(Smar). Connection is done as shown in fig 3.

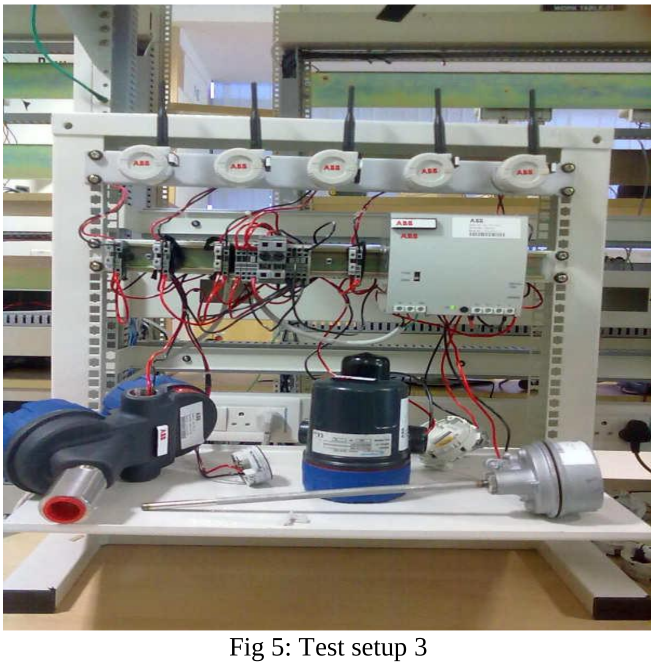

Fig 5: Test setup 3

Test setup 5 consists of 5 adapters, 5 field devices and a power supply module. Field devices connected to this setup are: Rx5 (Magnetrol), T 32 (WIKA), PTG (Yamatake), BAR 61 (Vega), 442 (Pyromation). Connection is done as shown in fig 4.

B. Upgrading the wireless adapter with new firmware.

Once the test setups are done, all ABB adapters are upgraded to latest firmware revision. FT232R is used for this purpose. FT232R is a USB to serial UART interface device which simplifies USB to serial designs and reduces external component count by fully integrating an external EEPROM, USB termination resisters and an integrated clock circuit which requires no external crystal, into the device.

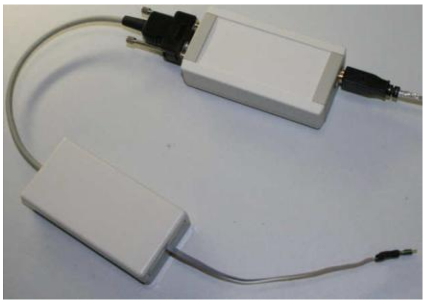

Fig 6: FT232R interface

Fig 7: Small 6 pin connector

First update-interface is plugged-in and COM port is identified, then COM port and baud rate is set in the software, baud rate is set to 9600. When we select 'load firmware' and click 'connect', firmware upgrade starts after few seconds and gets completed in nearly 120 seconds as shown below.

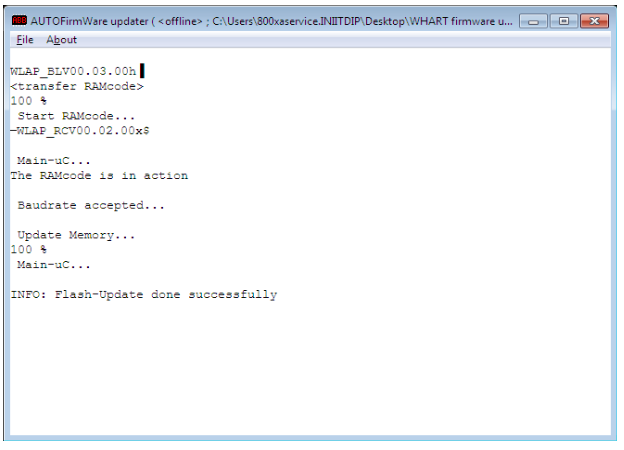

Fig 8: snapshot of firmware upgrade done successfully

The same procedure is followed to upgrade all the adapters.

C. Configuration of network ID and join key.

In this workflow HART modem of IFAK, a tool called FrameAlyst and a driver is used. IFAK interface is used to set the network ID of the gateway and join key to the adapters.

First we need to find out the polling address of the adapter and the device (By default ABB adapter will have polling address of 15 and generally device will have a polling address 0 otherwise use handheld device and change the polling address to 15 and 0 for adapter and device respectively). Then open FrameAlyst and select menu 'send' and then select 'cmd 0', device will respond as shown below.

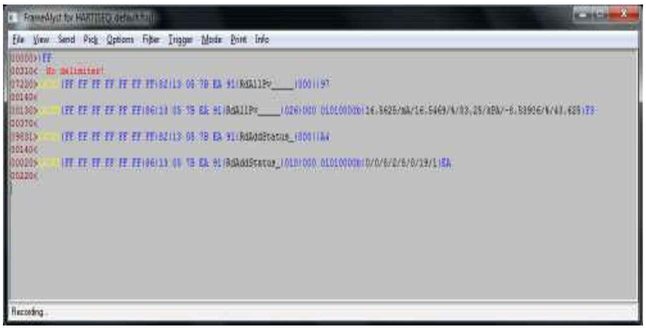

Fig 9: snapshot of device response

Now to check the network ID set in the adapter, select menu 'send', then 'any cmd' and then type the following series "31,2,3,06". Device will respond back, where we can checkout 2 bytes of data which is the current network ID and this will be in Hexadecimal. We can also change this network ID if we want. Now join key is set by sending the command '31,18,3,0' followed by join key. Then adapter is forced to join the network by sending command '31,7,3,3,1,99,99,99,99'. After this, adapter will join the network within 8 minutes. By typing the IP address of the gateway in the gateway webpage we can see the list of devices and adapters which are online.

D. Integration of wireless HART into DCS

Integration is done through communication interface (CI867) and configuring wireless HART using control builder M tool. Modbus TCP library can be used to read HART variables from gateway via Modbus TCP in AC800M controller using CI867 module. In order to use this library, we import the respective Modbus afw file in plant explorer, then insert it in CBM and connect the library to an application and create a control builder program. In the program, we insert a function block, define and connect variables to this function block. The function block will look as shown below.

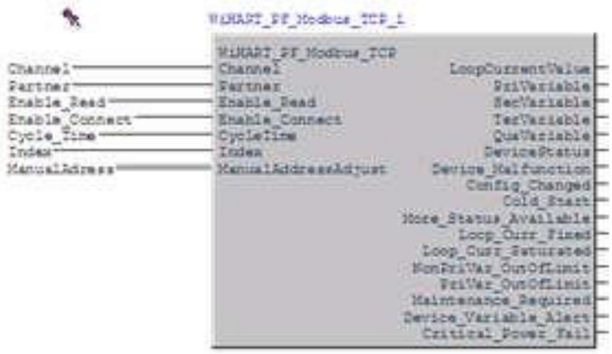

Fig 10: Functional block created in CBM

IV. EXPERIMENTAL RESULTS

After configuration of network ID and join key, adapters joined network which can be seen in the gateway webpage as shown in the below snapshot, we can observe the network start time, date and also the real time clock date and time. The network started on 14/5/2012 at 17:36:46.

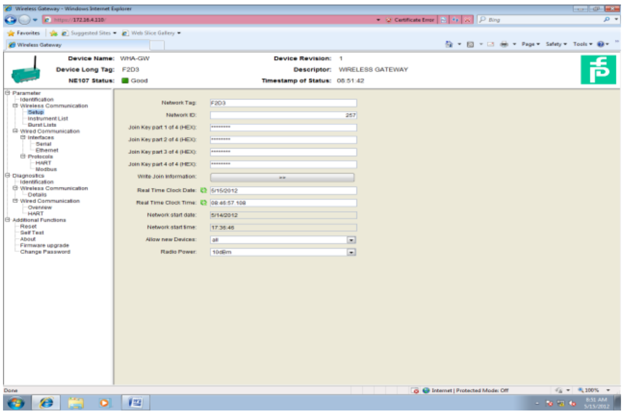

Fig 11: Snapshot showing network join date and time

On 15/5/2012 at 8:45:57.108, all the devices which had joined the network were still online. There was no communication lost with any of the adapters. All the devices were online and we were able to see device parameters like loop current, PV, SV, as shown below.

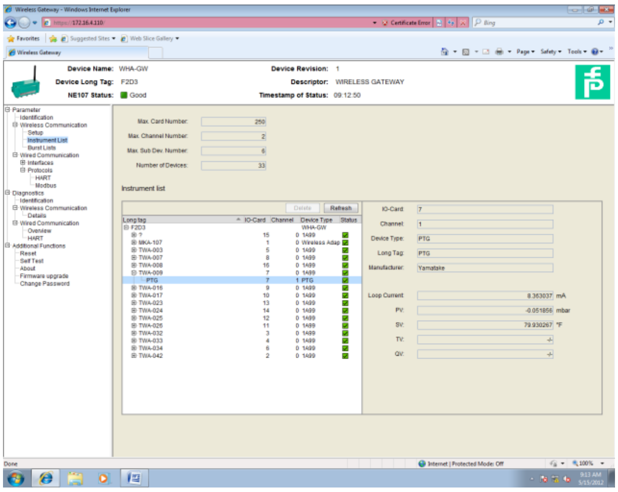

Fig 12: snapshot showing the list of devices online

On 16/5/2012, at 14:15:50.908 all the devices were still online and all the parameters of the devices are accessible.

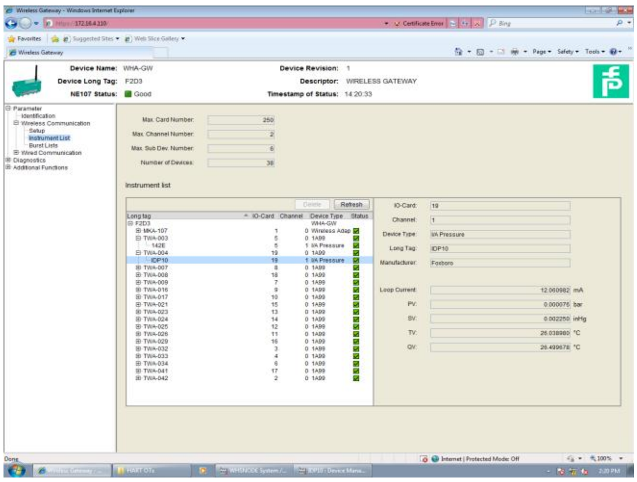

Fig 12: snap*shot showing the list of devices still online*

On 16/5/2012, at 2:53 pm; when we subscribed for the live data, we were able to access the device parameters and depending on the pre-configured device health monitoring conditions, alarms are raised on severity level and the status can be logged to the maintenance engineer to take corrective action.

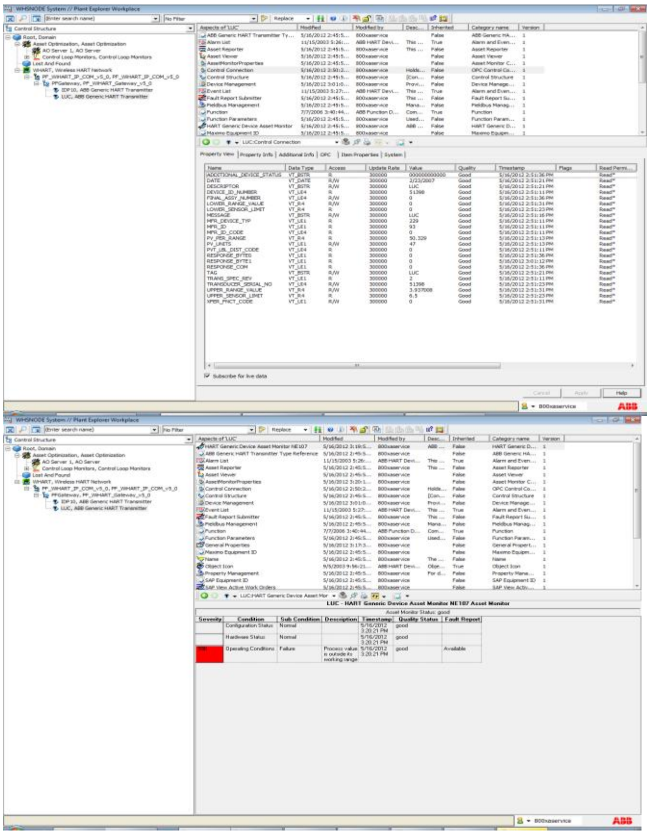

Fig 15: Snapshot showing live data subscription and alarm raised based on pre-configured severity

V. CONCLUSION

The proposed test suite results after the firmware upgrade of the adapter shows that there was no communication lost between the field devices and the host system. We can conclude that integration of wireless HART into DCS will redefine process monitoring, preventive maintenance and asset management in the near future.

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