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Oil & Gas Data Acquisition, Monitoring and Reporting System Upgradation Proposal for Titas Gas Field

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Abstract: Titas is the largest gas reserve field with production per day is 400 mmscf from 26 wells at different locations. Flow, pressure, and temperature of gas and oil level measurement system of Titas gas field in different locations are based on an orifice meter chart recorder, pressure gauge, temperature gauge, and liquid level measuring tape respectively. All data recording and reporting are paper-based and require huge man-hour involvement and a large volume of diesel is used for flow data collection and recorder maintenance & calibration. There is a continuous risk of mechanical error due to malfunction of any spare parts. On the other side, transmitters are almost free from man-made or mechanical error. Transmitters are proposed for the wellhead, oil storage tank, and flow line & sales line. A local data converter will convert data received from transmitters of every individual location and will send it to the GSM and RF transmitter through cable. The radio frequency transmitter and GSM module will act redundantly to transfer signals from locations to the central data acquisition center. Data can be processed by a programmable logic controller and visualized by screen in a monitoring room. This analysis is performed to suggest a completely automated data acquisition, analysis, and reporting system to replace the existing system with a desire to reduce cost and environmental damage.

Keywords: *Flow, pressure, temperature, transmitters, automation.*

Introduction: Bangladesh, as a developing nation with a burgeoning population and expanding urbanization, confronts substantial energy needs. Regrettably, the country experiences a shortage of readily accessible energy sources. Among various natural energy resources, natural gas assumes a pivotal role in driving national economic progress and mitigating energy scarcity[1]. The Titas gas field stands as one of Bangladesh's largest and most crucial commercial energy reserves[2]. This gas field produced huge amounts of gas and the flow, pressure, and temperature of gas and oil level measurement system of the gas field in different locations are based on an orifice meter chart recorder, pressure gauge, temperature gauge, and liquid level measuring tape respectively. Firstly, Gas flow data are collected by operators every two hours intervals and wellhead data of locations that haven't control room are collected after one day interval. A daily and monthly report is created by utilizing a planimeter and Microsoft Excel, and both data are generated by Excel sheet. Each sales recorder undergoes monthly calibration, and the oil level of every tank is assessed each morning. Secondly, Barton and Foxboro recorders are used in the Titas gas field. Foxboro had stopped its production and supply of paper-based flow recorders [3]. If Barton would stop manufacturing paper-based chart recorders, Chart paper collection is also become difficult day by day, then almost all gas fields will be faced a difficult problem. Thirdly, flow data are collected manually by production staff and there is a source of parallax error. Recorder-related mechanical error is more frequent. The chart paper recorder is constructed by using several small spare parts.

There is a continuous risk of mechanical error due to malfunction of any spare parts. Lastly, Every year, a large volume of diesel is used for flow data collection and recorder maintenance & calibration, which emits of CO2 emission to the environment[4].

This paper is performed to suggest a completely automated data acquisition, analysis, and reporting system to replace the existing system with a desire to reduce cost and environmental damage. Almost all oil and gas industries are switched their metering system to automation technology to reduce cost and to make system more reliable. On the other side, transmitters are almost free from man-made or mechanical error, and using transmitters and automatic data transmission systems will be totally emission-free. It will contribute to curbing global and will also contribute to complying with goal 7 of SDG about affordable and clean energy[5].

Materials & Method

Multivariable transmitter: A single transmitter can measure pressure, temperature, and flow simultaneously. Three sensors named pressure, temperature, and flow are the main parts of this transmitter. The flow indicator is designed to record the flow of mass which passes through the system. The recorded data is sent to the computer-based monitoring and controlling system. The readings are updated with continuous fluctuations. The system is set in a coded formula that gives the calculated value based on the HART protocol in a time interval [6].

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Ultrasonic flow meter: An ultrasonic flow meter measures the flow of oil and gas by sending ultrasonic waves across a pipe containing the flow in the direction of the flow and in the opposite direction of the flow. The ultrasonic waves and the velocity of the flow of the oil and gas can be combined to determine the flow rate. The transducer, the device that calculates the flow rate, can be mounted parallel or at an angle to the side of the pipe. Ultrasonic flow meters have transmitters that send the sound and receivers that receive the sound. The transmitters send out short bursts of ultrasonic signals or pulses through the flow of the gas. One transmitter, the preferred transmitter, sends sound waves along the direction of the flow.

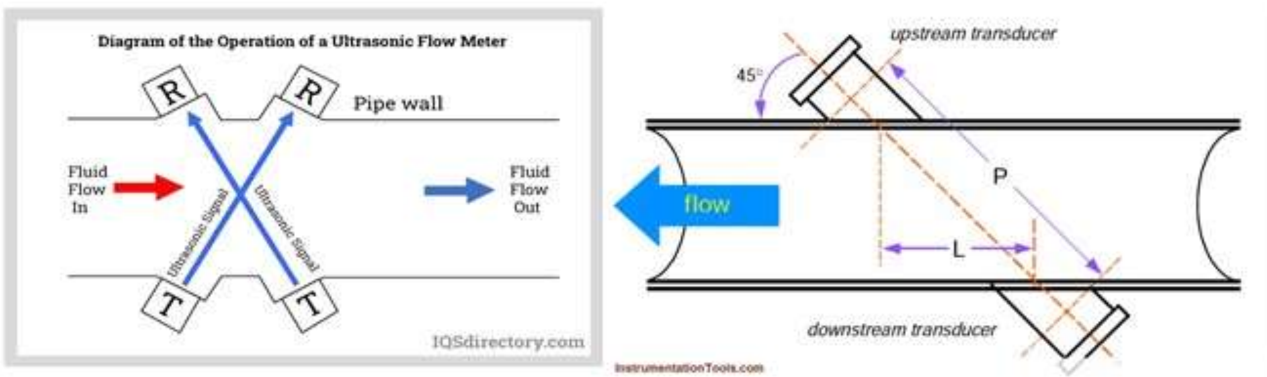

Figure 1: Operation of Ultrasonic flow meter [7].

The specifications of these flow-measuring devices are presented in Tables respectively.

Table-01 Technical specifications of ultrasonic flowmeter [8].

Item	Value & Specifications
Measurement Method	Ultrasonic Measurement of flow velocity
Damping Rate	6 (s)
Accuracy of reading	+/- 1.0% of measured range
Repeatability of reading	+/- 0.3%
Configurable pulse and relay output	Digital RS 232
Clamp & IP Rating	On M2 (on encapsulated IP 68 sensors require no pipe cutting)
Wide operating temperature range	0^0 C to 60 ^{0}C

Ultrasonic/radar level transmitter: Both ultrasonic and radar level transmitter (ULM) are non-contact type. Both are mounted on the top of the tank whose level measurement is needed. Ultrasonic waves are transmitted from the ultrasonic level transmitter and electromagnetic waves are transmitted from the radar level transmitter. Both types of waves hit the top of the material in the tank. After hitting the material, the waves travel back to the transmitter. The transmitter has a microprocessor that calculates the distance traveled by the waves and gives the level of data output.

Figure 2: Ultrasonic/radar level transmitter [9].

Table-02 Technical specifications of Ultrasonic/radar level transmitter [9].

Item	Value & Specifications
Measuring Range	Liquid (0.50 - 20.00 m) ; Solid (0.50 - 8.00 m)
Process Temperature	-40 to 70 deg C
Process Pressure	(-0.02 to 0.1) MPa
Accuracy	± 0.25% of full scale
Supply Voltage	24 VDC or 220 VAC
Output Signals	4-20mA; HART; RS485
Enclosure Material	Aluminium

Modbus protocol: Modbus protocol is a method used for transmitting information over serial lines between electronic devices. Modbus supports communication to and from multiple devices connected to the same cable network [10].

HART (Highway Addressable Remote Transducer) Protocol: The HART network is a worldwide digital data transferring protocol with analog wiring in between smart devices & control systems. It transmits digital data to the receiver to establish communication among host systems as well as field devices [11].

HRT -710 converter working procedure: Like transmitters, flow meters and read the data as required in the digital signal. HRT 710 is commonly used with HART devices for data converting and sending to utility software.

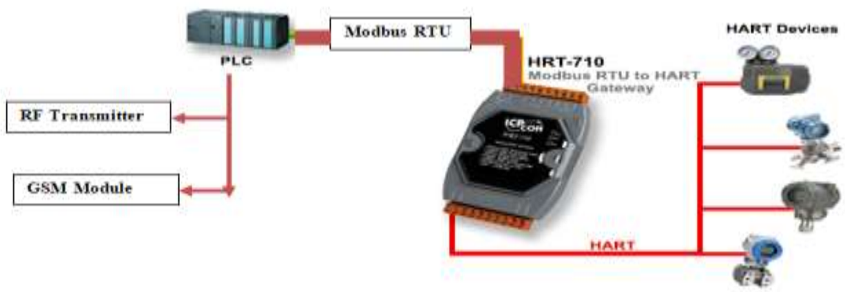

Figure 3: Working procedures of HRT 710 converter [12].

Radiofrequency: Radiofrequency consists of a transmitter and receiver section. A hardware subsystem called a microcontroller is used in both sections. The microcontroller converts the data into a signal and transmits it through the transmitter, the channel by which the signal travels, another hardware subsystem called the receiver receives the signal and propagates it in a decoder which converts signals to original data.

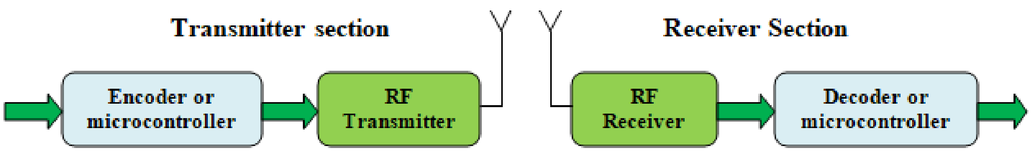

Figure 4: Working procedure of Radiofrequency [13].

Global System for Mobile Communication: A GSM module is a circuit that is used to establish communication in the automation industry. Modulator-demodulator, power supply circuit, and communication interfaces are important parts of GSM. It requires a Subscriber Identity Module (SIM) to activate communication with the network. Wireless modems generate, and transmit data from a cellular network, to establish communication. AT commands are used to control the modems where AT stands for Attention [14].

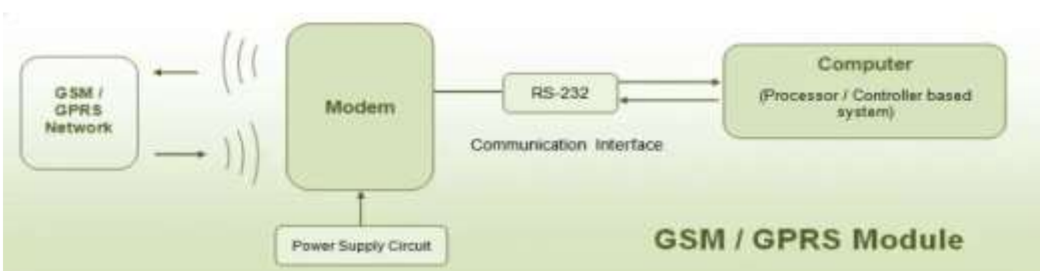

Figure 5: Working procedure of GSM [15].

Radio Frequency (RF) and Global System for Mobile Communication (GSM) are both integral to the world of telecommunications, albeit in different capacities. RF encompasses a wide spectrum of electromagnetic frequencies, spanning from 3 kHz to 300 GHz, and serves as the foundational technology behind various wireless communication systems. GSM, on the other hand, is a specific digital cellular standard that operates within the RF spectrum. It is engineered to facilitate voice and data communication in mobile networks, employing digital modulation techniques like Gaussian Minimum Shift Keying (GMSK) to ensure efficient data transmission.

Table 03 Comparison of Radiofrequency and GSM module.

Criteria	Radio frequency	GSM module
Installation cost	High, but BGFCL already has almost all relevant infrastructures.	Low
Operation and maintenance cost	Low	High, cause monthly bill will have to be paid.
Sustainability or reliability	Higher, as BGFCL already has an established radio network.	Lower, because its reliability will be dependent on the performance of the external service provider.

Supervisory control and data acquisition (SCADA): SCADA software is essential for industrial organizations to control processes, monitor real-time data, and communicate system issues. The software communicates with devices such as programmable logic controllers to interact with industrial equipment and processes.

Programmable Logic Controller (PLC): PLC is an industrial computer control system that continuously monitors the state of input devices and makes decisions based on a custom program to control the state of output devices. It is mainly used for Automation [16].

Human-Machine Interface: A Human-Machine Interface (HMI) is a user interface that connects a person to a machine or devices.

Methodology: Pressure-indicating transmitter (PIT) and temperature-indicating transmitter (TIT) are proposed for wellhead pressure and temperature data acquisition. Every flow line from the well to the process plant has orifice meter and chart recorder for measuring flow, pressure, and temperature. Using a multivariable (flow, pressure and temperature) transmitter instead of a chart recorder will be advantageous for flow data acquisition.

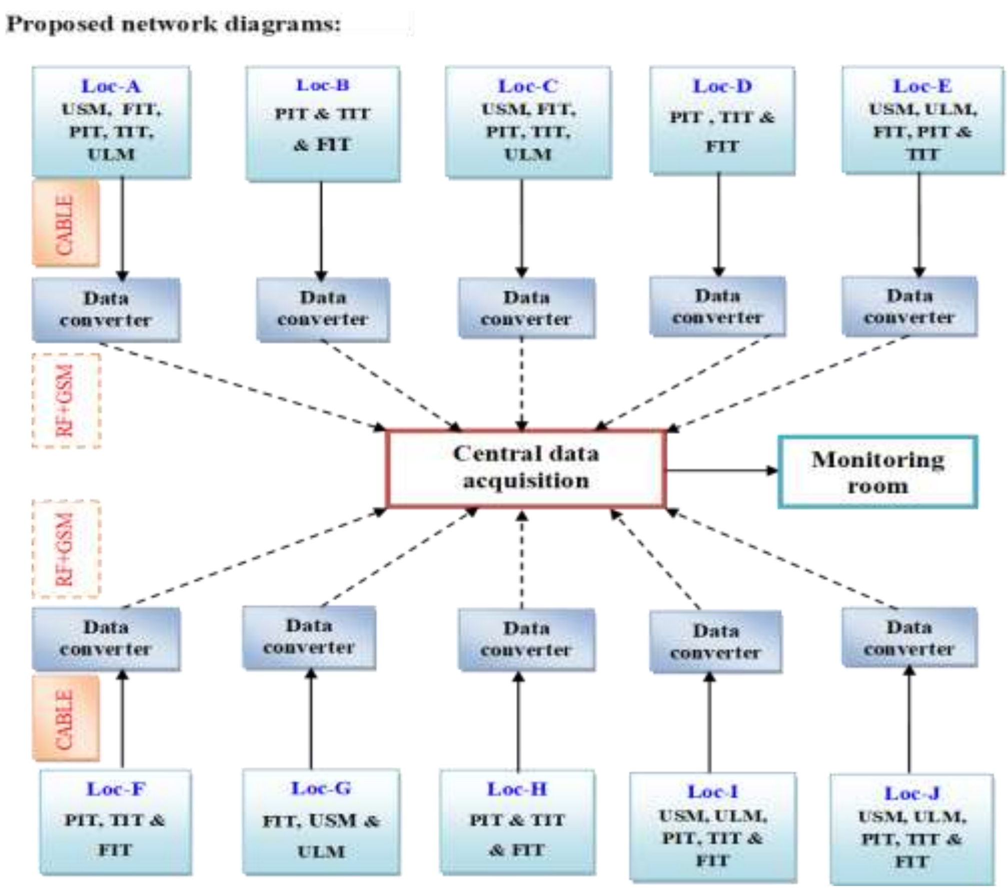

Figure 6: Proposed data gathering and monitoring systems of Titas gas field.

Ultrasonic flow meter will be the best selection for most accurate and maintenance free sales line flow measurement. Ultrasonic/Radar level transmitters are the latest technology for oil level data acquisition. A local data converter will convert data received from transmitters of every individual location and will send it to the GSM and RF transmitter through cable. The radio frequency transmitter and GSM module will act redundantly to transfer signals from locations to the central data acquisition center. RF is considered as the primary data transmission system as Titas field already has some relevant infrastructure and its operating and maintenance cost is much lower compared to GSM. In the central control and monitoring center, flow data will be processed, and visualized and will generate hourly, daily, monthly, and any other customized report as required.

Results and Discussion:

Overview of proposed System architecture (Data Acquisition, Monitoring, and Reporting): Transmitters are proposed to the wellhead, oil storage tank, and flow line & sales line. A local data converter will convert data received from transmitters of every individual location. The programmable logic controller will process the data and will send it to the GSM and RF transmitter through cable. The radio frequency transmitter and GSM module will act redundantly to transfer signal from locations to the central receiver and after that send the data acquisition center. Centrally data can be processed by a programmable logic controller if we want and then visualized by screen in a monitoring room in Figure 7.

Anticipated improvements in data accuracy and quality: The implementation of an automation system in a gas field holds the promise of significantly enhancing data accuracy in several key ways. First and foremost, automation reduces the reliance on manual data entry and monitoring, eliminating the potential for human error. Sensors and instruments integrated into the system can continuously and precisely measure parameters such as gas flow rates, pressure, temperature, and composition, ensuring real-time, accurate data collection. Furthermore, automation allows for instant data transmission and processing, reducing the lag time associated with manual data handling. Predictive analytics and machine learning algorithms can be employed to detect anomalies and optimize operations, further bolstering data accuracy. Moreover, with the integration of remote monitoring and control capabilities, any issues or discrepancies can be swiftly addressed, minimizing the chances of data inaccuracies going unnoticed. Ultimately, these anticipated improvements in data accuracy not only enhance operational efficiency but also contribute to a safer and more reliable gas field operation. So, this process enhanced real-time monitoring capabilities and improved decision-making processes.

Cost savings and operational efficiency gains: The implementation of an automation system in a gas field is expected to yield substantial cost savings and operational efficiency gains. By reducing the need for manual labor and human intervention, labor costs can be minimized, and the potential for human errors in data handling and process control can be significantly reduced.

The yearly data acquisition, processing, and reporting cost for gas and oil production is 61,66,660 taka and the proposed system will require an investment is 12,69,24,960 taka(Prices of various instruments are collected from the website). However, fully automated data acquisition will decrease total operational staff and officer requirements. Industrial data transmitters require very little or zero maintenance work. The yearly maintenance/replacement cost is assumed 10 lakh taka.

Environmental and safety benefits: The utilization of an automation system in the management of a gas field delivers substantial environmental and safety benefits. Automation minimizes the environmental impact by precisely controlling processes, reducing emissions, and optimizing resource extraction. This not only helps lower the carbon footprint but also aligns with environmental sustainability goals. Moreover, automation enhances safety by reducing the need for human presence in potentially hazardous areas, mitigating the risk of accidents, and ensuring the well-being of personnel. Real-time monitoring and predictive maintenance capabilities inherent in automation systems further bolster safety by allowing swift responses to safety concerns. Overall, an automation-driven gas field not only enhances operational efficiency but also exemplifies a commitment to environmental responsibility and worker safety. Every year, 145800 liters of diesel are used for flow data collection and recorder maintenance & calibration, which is equivalent to 118 tons of CO_2 emission to the environment. Using transmitters and automatic data transmission systems will be emission-free. It will contribute to curbing global and will also contribute to complying with goal 7 of SDG about affordable and clean energy.

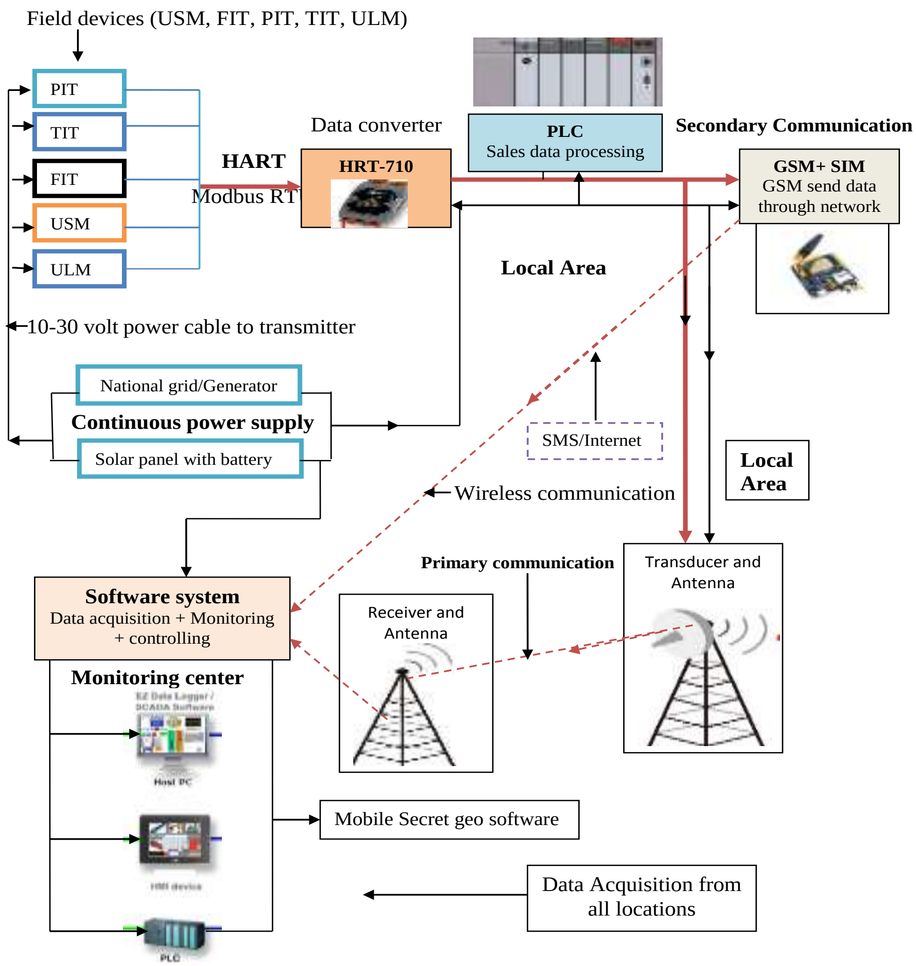

Figure 7: Data communication network of different location.

Conclusions: It is concluded, that this analysis is performed to suggest a completely automated data acquisition, analysis, and reporting system to replace the existing system with a desire to reduce cost and environmental damage. Automated data acquisition will decrease total operational staff and officer requirements. Industrial data transmitters require very little or zero maintenance work. The other lucrative outcomes will be avoiding technological obsolescence and reducing carbon footprint & contributing to complying with goal 7 of SDG about affordable and clean energy. Bangladesh will take part in the desire of our policymakers to build 4IR & SMART BANGLADESH.

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Symbol and Abbreviation

CPU= Central Processing Unit
DS= Downstream
FIT = Flow Indicating transmitter
GSM= Global System for Mobile Communication
HART= Highway Addressable Remote Transducer
HMI= Human Machine Interface
PIT = Pressure Indicating Transmitter
PLC= Programmable Logic Controller
RF= Radio frequency
RTU= Remote terminal unit

SIM = Subscriber Identity Module
SCADA= Supervisory control and Data Acquisition
TIT = Temperature Indicating Transmitter
ULM= Ultrasonic level transmitter
US = Upstream
USM= Ultrasonic Meter

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