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Integration between Radio and Satellite Phone System

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Abstract- Reat-time data communication from a point to another point is one of the crucial things for large enterprises especially in the oil and gas fields since they have several plants and rigs in remote areas which requite real-time and reliable communication to ensure that the business and operations are running smooth without any interruption in order to achieve corporate values. The main communication method inside the plants is handheld radio over radio base stations while the main communication method for rigs is utilizing satellite phone over through LEO satellite. Integrating the two systems through establishing direct connectivity between radio servers and satellite phone servers are vulnerable to several major threats that might impact the enterprise operations and security since satellite phone TAE3 encryption. This paper sheds light on a solution that integrate radio and satellite phone system through a box that contains a microcontroller, handheld radio and satellite phone to provide a real-time and reliable communication between plants and rigs. This solution is done by utilizing an intelligent box. The paper highlights the motivation of inventing this solution. After that, the major elements of the intelligent box and its working mechanism will be discussed. Finally, some challenges and difficulties are going to be presented, and then the paper proposes some solutions to overcome such challenges.

Keywords- Remote Areas, Radio System, Satellite Phone, and Integration

I. INTRODUCTION

The global demand for real-time and reliable data communication in the oil and gas recently increased since it can add a great value by increasing the net profit and decreasing the expenses. As a result, the idea of communication network came to light which focuses on data communication [1].

Communication network is a method of transferring the data within several networks within the enterprise such as normal end-users, operators and servers. This is very challenging concept in enterprise applies multi-vendor methodology since integrating different network equipment from several vendors is difficult since it might face compatibility issues in term security, functionality and operational. This could be solved by utilizing APIs, integrated servers and intelligent tools [2].

Radio system and satellite phone system is one of the systems that need to be integrated to ensure real-time and reliable data communication between plants and rigs in the oil and gas enterprises. This is very challenging and could not be done by applying APIs and integrated due to incompatibility between the two systems in term of encryption and hashing [3].

This paper goal is applying an intelligent box that contains microcontroller, handheld radio and

satellite phone. The microcontroller has voice sensors to detect source voice source whether it is from the handheld radio or satellite phone. After that, an actuator that is connected to the microcontroller will push the button of the other device, so the voice signal can transfer smoothly from the handheld radio and satellite phone and vice versa.

The paper explains deeply the motivation behind this solution and then it discusses the major elements of the box and how it works. Finally, it presents some challenges and difficulties were faced during implementing the solution, and then it sheds light on a method to overcome such difficulties.

II. MOTIVATION OF INTEGRATING RADIO SYSTEM AND SATELLITE PHONE SYSTEM

Oil and gas enterprises are mainly focused on drilling work over, extracting oil and gas from rigs, refining oil and gas, operating and maintaining plants and refineries, shipping and reserving oil barrels and managing production oil and gas pipelines. As a result, this requires a unified real-time reliable communication method maximize the company profit and reduce expenses. Unfortunately, a unified communication method cannot be applied under all circumstances since each operations environment have limitations affect achieving this objective for instance in satellite phones are the only available solution in rigs and marine terminals due to high mobility of drilling equipment and lack of fiber while radio system is applied in plant and refineries. Therefore, this section sheds light on the motivation of integrating the satellite phone system with radio system the optimize and enhance the oil and gas production and shipping to maximize the income [4].

Remote Areas

One of the major issues for the oil and gas companies is that they have scattered offshore and onshore rigs. In addition, lying fiber cables to connect these rigs to the corporate is completely inefficient since it is extremely expensive as 1 meter of trenching costs $80. As a result, connect rigs to the corporate network through satellite is the only available solution. This results of utilizing a satellite phone in the rigs instead of the handled radio.

Due to the nature of rigs, rig operators can use only satellite phone to call plant operators to control the rate of oil and gas extracting. Moreover, the satellite system has very limited bandwidth which means plant operators cannot use satellite phones as they may consume the whole bandwidth which results in affecting the communication in rigs.

As a result, this motivated communication engineers in the oil and gas fields to work together in order to find a reliable secure method integrating the radio system and satellite phone system.

Real-time Actions

During incidents, taking the right and correct actions are crucial to the safety of the employees since rigs and plants are dealing with volatile gases such as carbon dioxide, carbon monoxide, xylene or ethyl that may cause cancers or explosions.

To help saving the employee and company's assets, the time of transferring data plays important as couple of delayed minutes may causes unwanted and unexpected injuries and incidents. Therefore, the method of exchanging data is the rig foreman calls the control room foreman through satellite phone, and then the control room foreman calls the plant foreman through radio. This takes couple of minutes and in the oil and gas field every second is matter.

As a result, the motivated the operation engineers to in the plants and rigs to find a method of exchanging from a point to another with minimum time while reducing number of hops in between. The intelligent box helps a lot achieving this objective with only 7-8 delayed seconds.

The Design of Intelligent Box

This section explains the major components in the intelligent box which are a handheld radio, satellite phone and microcontroller. After that, it discusses

the working mechanism of all the elements together.

Components

As mentioned above, the box contains three main components which are a handheld radio, satellite phone and microcontroller. Arduino Uno was utilized as a microcontroller. Both handheld radio and satellite phone are one way communication which means they either transmit or receive the voice signal and they cannot do both at the same time [5]. The status of transmitting or receiving voice signals is decided by voice sensors and actuators that are connected to Arduino Uno. The functionality of these voice sensors and actuators are going to be discussed in the next subsection.

Working Mechanism

As explained in the previous subsection, voice sensors and actuators are playing crucial roles in the integration since they decide based on the signal direction and voice source which device in transmitting or receiving status.

For example, in case the rig foreman utilized the satellite phone in the rig site to transfer a message to the plant foreman. The signal is going to travel the satellite phone in the rig to the satellite phone in the box through LEO satellites. After that, the voice sensors will detect some voice signals come out from satellite phone in the box, these readings will be processed in Arduino Uno code. Based on these readings, Arduino Uni will know that satellite phone is receiving status, and it needs to transmit the message to the handheld radio. As a result, Arduino Uno sends commands to actuators to make the handheld radio in the box in transmitting status. The handheld radio in the box transmits the message to the handheld radio in the plant site through radio base stations. In the scenario, the satellite phone was in receiving status while the handheld radio was in transmitting status.

The other way around, when the plant foreman wants to exchange some information with the rig foreman, the process is going to be the same except one thing which is handheld radio in the box is in receiving status while the satellite phone is receiving status.

This approves that the voice sensors and actuators that are connected to the microcontroller are crucial elements since they decide which direction the voice message is going to and based on that set the devices in the box to receiving and transmitting status.

III. IMPROVEMENT ASPECTS OF DEPLOYING THE INTEGRATION BETWEEN RADIO AND SATELLITE PHONE SYSTEM

Oil and gas companies support implementing innovative ideas that enhance the process of operations and maintenance while keeping the employee safety a priority and protecting the IT infrastructure from any cybersecurity threats. The intelligent box successfully these pillars which enhancing safety, optimizing operations process, maximizing maintenance quality and mitigating cybersecurity threats. This section sheds light safety, operations, maintenance and cybersecurity by highlighting positive applications of the intelligent that supports the mentioned pillars.

It worth to mention that again to help understanding the applications for each pillar, all departments in the oil and gas companies are utilizing radio since it is more reliable and abundant bandwidth that can support thousands of customers while satellite has less reliability and limited bandwidth which means it is highly recommended to be only utilized by offshore and onshore rigs.

Safety

The integration between the radio and satellite phone through the intelligent box has several positive impacts on the employee safety since rigs may dangerous situations that require urgent support from hospital emergency centers for instance explosions, emitting toxic gases and rig collapses.

The traditional method of reporting these emergency situations relies on informing a dispatcher in the oil and gas operations center, and then this dispatcher conveys the message to the emergency center to provide the required support. This

The enhanced method of reporting the incidents in rigs after applying the integration inside the box is eliminating the dispatcher from the process by establishing a direct contact between the rig foreman and hospitals. This reduces the number of hops between rigs and hospitals which leads to dispatch the rescue team to the rig faster.

Operations

Keeping the rig under operation 24/7 is one challenges in the oil and gas field since several obstacles may face the rig operators that may impact the production pipelines. As a result, a reliable sustainable communication channel is one major things that needs to be obtained between the rigs and the plants which can be achieved by the intelligent box.

The traditional method of communication takes 20-30 mins to transfer the messages from rigs to the plants and another 20-30 mins to transfer the responses back to rigs since it evolves several hops (employees) in between to exchange messages back and forth.

The optimized method of exchanging messages through the intelligent box ensures supplying the plants with oil and gas 24/7 without affecting the business continuity since it decreased the time to 1-2 mins.

Maintenance

Several oil and gas entities have to implement regular Preventive Maintenance (PM) for the production pipelines in the offshore and onshore. These PMs require some precautions such as decreasing or increasing oil and gas pressure in the pipelines to protect the employees. The oil and gas pipelines are lying over millions of kms as the case in Saudi Arabia. As a result, it is extremely difficult to manage PMs since the pipelines are fallen within areas that has no radio coverage and as known PMs require a lot of coordination between plants and rigs.

The integration between the radio and satellite phone system helps mitigating the risks from conducting PMs by providing a reliable communication channel to ease the exchanging commands during the PMs.

Cybersecurity

The cybersecurity posture is extremely since it indicates how the IT infrastructure is vulnerable to cybersecurity threats and attacks. Any new implementations bring several threats need to be addressed. For example, if the integration is applied through a server or API, this is going to bring some potential vulnerability that can be used by black hackers to penetrate the organization.

The integration through the box does not bring any new vulnerabilities since it is just a very physical implementation in small area which means it is away from hackers' hands. As a result, this keeps the IT infrastructure save and protect the corporate by ensuring the cybersecurity posture does not bring any new threats.

IV. OVERCOMING CHALLENGES RELATED TO DEPLOYING THE INTEGRATION BETWEEN RADIO SYSTEM AND SATELLITE PHONE SYSTEM

Every new innovative idea or solution comes with its difficulties and challenges. The best practice to overcome these challenges is utilizing and integrating different innovative ideas to together. This section discusses some of the challenges of implementing the intelligent box in the oil and gas fields and the method was utilized to overcome them. One of the challenges is having several talk groups in radio and satellite phone where it was solved by having several intelligent boxes. Moreover, one of the difficulties is ensuring high privacy during exchanging information where it was solved by using an isolated metal for the box.

Several Talk Groups

One way communication systems are anchored on creating several groups in order to segregate the process of exchanging messages which leads to ensure high levels of confidentiality in radio and satellite phone system. This means the exchanged information will not be disclosed to unknown parties. The idea of several talk groups creates an issue where data may get breached to other groups that are intended to receive specific message if the handheld radio and satellite phone in the intelligent box are serving several talk groups.

The issue was addressed by ensuring that the handheld radio and satellite phone in the box serving only one talk group. This leads lead to increase the number of boxes to 12 times but this is not an issue where it is not costly and it ensures high levels of confidentiality.

Confidentiality

The intelligent boxes are kept in a safe location with IT inside data centers but some customers were highlighted some concerns where they are afraid of unknown parties can be around the box and listen to them. This considered a critical vulnerability since all the exchanged information are confidential and cannot be disclosed to other parties as it contains critical data about oil and gas production and coordination of critical locations.

Customers' comment was taken seriously, and it was fixed by making the box made of specific type of metal that prevent voice propagation through it. As a result, anyone around the box cannot hear any voices inside the box.

V. CONCLUSION

In summary, this paper presented the motivation and business needs of deploying integration between two different communication systems which are radio and satellite phone for instance communication in remote areas and support taking real-time actions to ensure the business continuity. Moreover, the paper highlighted the major components in the integration box and then it deeply discussed the functionality of each component in the box under different scenarios. Furthermore, the paper shed the light on the positive impacts that generated from the integration that supports the corporate values for example safety, operations, maintenance and cybersecurity. In addition, it presented some challenges that faced deploying the innovation such as dealing with several talk groups and ensuring confidential communication. Also, it illustrated some solutions were applied to overcome these difficulties such as utilizing a separate box for each talk group and utilizing isolated metal to prevent voice propagation outside the box. Finally, IT fields is developing rapidly, and it is producing several promising solutions that can improve integration between the radio and satellite phone through the intelligent box.

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