Computer Aided Decision Systems - Industrial practices using Big Analytics

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Lecture 30
BDA in IIoT, Gas Pipeline Case Study

Welcome back to the lecture series, where we are discussing the big data analytics in the Industrial IoT system. I have discussed various elements: the structure and the layer of the Industrial IoT system, the use of big data analytics. So, what are the various elements or the different big data analytics in IIoT is a big system, what are the subsystems, what are the sub subsystems, what elements could be used, they could be specific sensors, they could be specific softwares. So, let us take a few examples or case studies.

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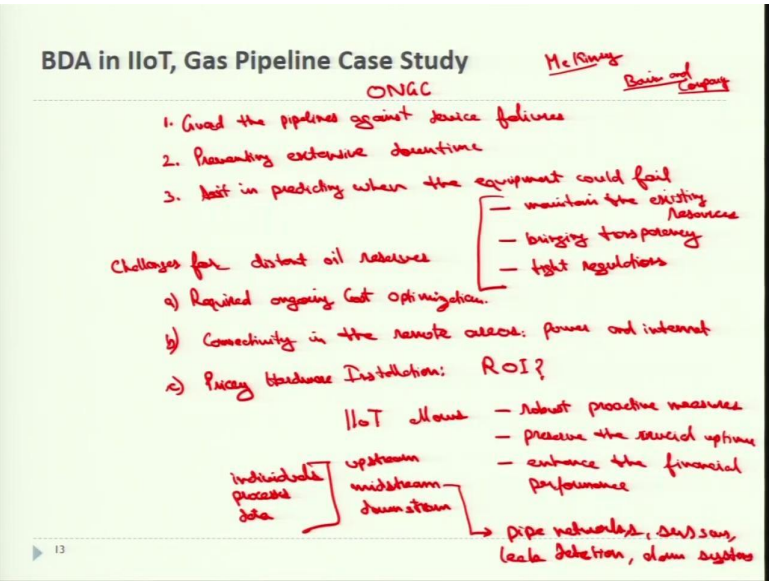

The first case study I would like to take is the Gas Pipeline Case Study. How does the big data analytics or installing the sensors at different points in the gas pipeline to avoid leakage for regular maintenance, for having the data from the remote areas. This will help us to have the financial as well as the long life benefits. So, oil and gas markets are considering what can be acquired from deploying IIoT modern technologies by gathering and analyzing the data from the history assets, while realizing significant gains from connecting the new recoupments.

So, this is a case that is studied by McKinsey and a few things that are also reported by Bain and Company. This is similar to what we can do, suppose we have our own gas agencies like Oil and Natural Gas Corporation India (ONGC).

So, major concerns of a gas pipeline is,

1) To guard the pipelines against device failures
2) Preventing extensive downtime
3) To assist in predicting when the gas extraction equipment would fail.

So, along with searching for new oil reserves or gas reserves, it was an important point to maintain the value of the current properties which suppose ONGC is holding. So, this required transparency in the business practices and tighter regulations were there.

- So, they maintain the existing resources
- Bring transparency. Transparency means whatever data is submitted or whatever data is analyzed also be kept transparent because in case of any catastrophe or any failure, the stringent requirements, the government regulations are there which are to be reported back.
- So, everything has to be reported timely and in a transparent manner. So, this has to be met to deal with the tight regulations. This is one major issue.

With the Industrial IoT case study, one of the cases it was taken was for the oil reserves which were distant because oil reserves are generated distant and the places where you manage them are at offices or the cities which are big or so. So, the distant oil reserves have different kinds of challenges for them. I would say challenges for distant oil reserves where,

a) Required ongoing cost optimization because the oil reserves were distant. They were not very productive, the volume of the oil that was being extracted or produced or generated by them was quite low and the investment which was required in purchasing these sensing equipment or the sensors was heavy.

So, ongoing cost optimization, where the trade-off between the investment and what could we actually get out from finally applying or employing the analytical models and getting the reduction in the cost, in the total maintenance. So, this was a cost optimization problem statement. These statements are akin to the hypotheses that we can design. So, this is cost optimization while installing the sensing units or so.

b) Second was, the connectivity in the remote areas which means it was difficult to have access to power or web connectivity both. So, both electricity and internet. On top of having the sensing unit itself being very expensive.
c) The installation of these units on the equipment which were old, which was volatilely cunning and getting outdated or so, to put those sensors over their installation cost was also very heavy. So, this was also a challenge. I would say pricey hardware installation. It means the cost of the sensing unit is high, cost of installation is also high, which increases the cost of the original sensor. So, additionally the software applications also need to be built. So, return on investment was very crucial here, ROI was under a question, because smaller procedures as well as more remote and end of life wells to justify the IIoT applications. This is a challenge.

Now, operators were to be able to manage, analyze and take actions on vast information collections from numerous physical assets which were deployed for production and transformation of hydrocarbons. So, it is a big benefit of IIoT that it enables the consolidation of disparate data into structured data groups which can be analyzed into small clusters and to find patterns which indicate a potential risk or equipment failure.

So, IIoT allows,

- Robust proactive measures, like preventing maintenance or activation of extremely early question signals or so.
- Then, it could also help to preserve the crucial uptime which, in turn, would definitely enhance the financial performance.

So, individuals should have been able to process data. So, the elements here would be individuals, the processes, the data points from the processes, the points across upstream, flow, midstream and downstream.

So, there are countless ways that business IoT can be used in the oil and gas industry. Moving varying quantities and quality of goods from various locations to new end users as well as markets is a difficult task for the midstream market. Industrial IoT is an essential tool for the midstream service because it connects pipe networks, sensors. So, in the midstream, it can connect pipe networks, sensors, leak detection, alarm systems or emergency situations. So, this is the major business obstacle in the problem statement, that is there.

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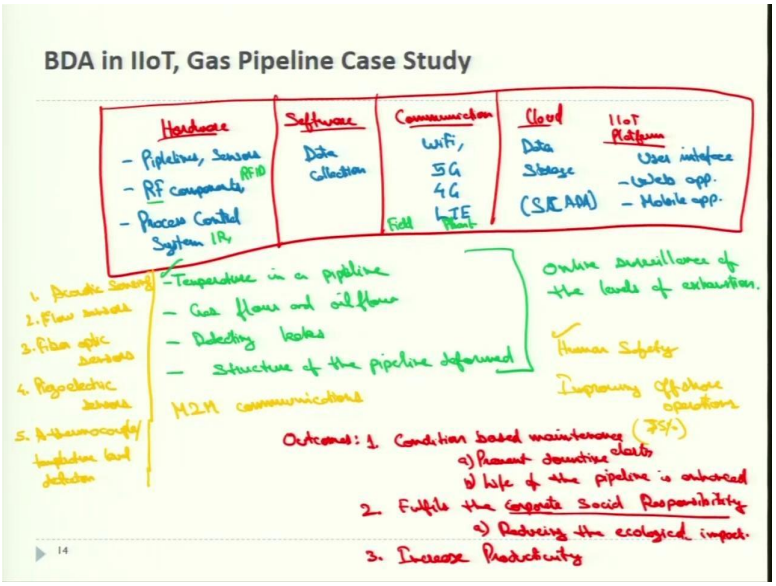

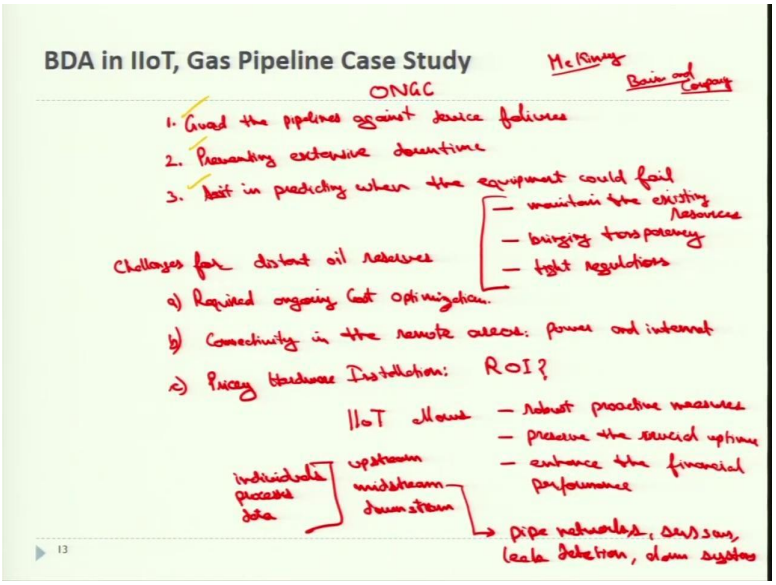

So, a business obstacle if I put it in very clear terms, for this case study could be the pipes are generally susceptible to multiple structural failures, which means, deboning, cracks, leaks or rust could back there. Stress on the pipeline varies frequently. So, if I tried to put it in a block diagram, I could see we have

1) Hardware,
2) Software,
3) Communication
4) Cloud
5) IIoT platform.

1) In the hardware, definitely, pipelines constitute the first element. Then we have the sensors. What different sensors are there that we will also discuss. Then we have the radio frequency components which are a kind of sensor itself. And we have a Process Control System.
2) The software definitely requires data collection device integration or real time analysis is required. So, hardware goes to the software system in which data collection is the major concern.
3) I will put communication where Wi-Fi is a wireless line or some connections to if not Wi-Fi. Maybe if not 5G, 4G connections or LTE connections were required to transfer the data. For this to have a gateway that all the data is transferred. It could be IP four or IP six kinds of data.
4) So, data storage is taken care of by the cloud.
5) It could again be supervised controlled data and the IIoT platform, which is a user interface or web app of my mobile app. That is the operator or the person who is going to monitor should have it on his computer on a website or on a mobile. This is majorly a structure of the elements of the case study that we are going to take.

Now, what could have been the challenges? In the pipes where multiple structural failures could come, the pipes could have cracks, leaks, rust or so. The stress in the pipelines varies frequently, as I said, the majority of pressure drops are caused by regular activities like chemical plant expansion or nuclear power plant gas down or so. So, other stress reductions might be brought by odd circumstances like leaks or ruptures. So, developing an automatic system, which is both quickly and accurately responding and detecting the anomalies, is required.

So, the main causes of tension in the pipes could be, if I put them in, I can just also deploy what kind of sensors would help us to take care of them.

- So, it could be temperature in a pipeline.
- It could be gas flow and oil flow
- Detecting leaks
- Structure of the pipeline itself deformed

So here, the leaks or the major tension in the pipe that has come, could be because of the internal stresses that weight may be restrained thermal expansion. Incomplete relaxation is important to consider a light of increased temperature and stress levels as well as other predictions that there will be influences like increased friction in pipe supports that could also add to the issue. An essential prerequisite for maintaining functional dependability on creating maintenance along the evaluation period and ensuring this free long term operation of the gas plant is online surveillance of the levels of extortion.

These pipes are thick walled components and relaxing the pipe system above the specific capability is not allowed. So, there were requirements of the sensors for different applications. For example, for temperature a thermocouple could come. For gas flow, there could be flow sensors for the leakage in the oil or so, there could be piezoelectric sensors to understand whether this section in the pipeline is deformed or not. So, these sensors are required. The industry wireless technologies majorly fall into two broad categories. That can have a significant impact on oil and gas operations. One is for the field networks, one is for the plant networks. Both of them can be wireless technologies depending upon the requirement; for the plant itself, Wi-Fi could be employed, for the field, a moving technologies required. So, I would just put them into two forms, field and plant.

So, for the field networks or for the field network sensors, the gadget applications are required. For the plant networks, business and procedure needs were required. So, this could be infrared radiofrequency which makes the part of the hardware itself or I would put them here as well. It could be an infrared sensor, it could be RF, it is already mentioned here, it could be RFID as well it is Radio Frequency Identification or so. Maybe at the satellite itself the things could be stored.

1) Now, to deal with these challenges, which are put here, temperature in the pipeline, gas flow and oil flow, detecting leaks, structure of the pipeline is deformed or not there has to be sensors such as acoustic sensing devices, which are used to identify acoustic signature variations that have been violated that means the gas flow is not streamlined, so this could be one.
2) Other than that, we have flow sensors. Flow Sensor is a device that is used to calculate the liquid velocity. It is for oil flow only in general.
3) Then we have fiber optic sensors. It is used majorly for structure of the pipeline, if it is deformed that could be seen, if desosting resources are there.

4) Then we have piezoelectric sensors which help us to determine whether the pressure flow or pressure changes are there that could be also measured.
5) Temperature is also to be measured. We need to have a thermocouple or maybe a thermal level detector which I have put as an IR temperature level detector. This is used to gauge how a metal's electric wire resistance varies with temperature. So, that is helpful to have surveillance and to have control options which should be avoided by the wireless M 2 M communication. Wireless M 2 M communication if I say, M 2 M means the communication happened between Machine to Machine. Along with the challenges or the problems which were mentioned here to guard pipelines against device failures, to prevent extensive downtime or assist in the predicting whether the equipment would fail or it could fail. Human safety was also a challenge. So, the oil and gas companies are using big data and predictive analytics to identify new oil and gas sources without having to conduct potentially hazardous operations that means difficult to reach areas or where there could be potential hazards to the human that could also be reached using IIoT sensors only. This is human safety, that is also enabled.

- Next point is, reducing the production costs. Big data can be harnessed by these companies to improve the production efficiency that is reducing cost, so data analysis is being used to identify the right place to dig oil wells even. Then upstream, midstream, downstream optimization could happen that I just said. So, this remains one of the most important applications of big data analytics in the oil and gas industry. Drilling efficiency is improved by implementing best practices, which were formulated by harnessing the data from the past, that is the automatic monitoring service device. Automatic monitoring devices or services that developed. Then predictive and preventive maintenance is always there.
- Now, improving off-shore operations. Improving off-shore operation means whatever is away from the plant. So, according to a report by McKinsey, that as I said, a typical off-shore platform runs 75 percent of its maximum production capacity. On average, the shortfall represents hundreds of billions of annual revenue. A primary reason for this performance gap is the operational complexities in the production and processing facilities. So, control room operations of an off-shore platform must be analyzed and when we analyze that, the data is really huge or humongous, that is big data is generated. And, there could be a sense of maybe rounding to tens of thousands which could be considered an external factor. But these are very well required or be very

useful if a typical off-shore platform is to be identified using big data analytics. So, advanced analytics can be used to identify bottlenecks and suggest prescriptive actions essential for smooth operations and conditions. So, these sensors are installed acoustic sensors, flow sensors, fiber optic sensors, piezoelectric sensors, thermocouple; I have only mentioned a few important and critical sensors. There are, as I said, thousands of sensors which are installed.

So, these sensors collect information and various data points are collected and which is cleansed and moved to the next level. Finally, the GUI, the web browser or the mobile application is there, that helps us to understand or make decisions. So, this acts as a Decision Support System to understand the operations of the oil and gas companies digging oils then maintaining the oil pipelines, this all is assessed upon.

So, majorly if I say outcomes of this is,

1) Condition based maintenance alerts, which means Industrial IoT actually monitors the pipelines and alerts and designated supervisors, mining engineers or environmental engineers or operators, they can take the call using this Decision Support System, a decision could be taken by this support system when the parameters in the pipeline depart from their recommended specifications.

a) So, this can prevent downtime because information has been gotten by the people who are not going to take the decisions and also,

b) It extends the life of the pipeline because the decision could be taken then and there, a decision taken time is also almost real time. So, the defect does not remain for more time and then all the defects do not aggravate. So, that is why the life of the pipeline is also enhanced.

2) Second major outcome I would like to put here is that it also fulfills corporate responsibility or Corporate Social Responsibility. What do you do? Is it not a 2 percent CSR fund, CSR does not only involve the financing. CSR funds are taken by the people of the startups to develop the products that will benefit the society in general. Here when I say CSR, it means minimizing the emission of hydrocarbons. The pollution is reduced, the leakage is reduced, if the leakage happens, if something very undesirable happens in the case of accidents, that is a big backlash to the company.

a) So, Corporate Social Responsibility is enhanced while reducing the environmental impact, ecological impact.

3) The development of the Industrial IoT system has given rise to the ability to increase productivity. We will put it as the third point. Or control and process monitoring helps us to have a better process. So, by extending current capabilities like real time data, capturing machine breakdown signals, real time control, data logging, information evaluation visualization. Industrial IoT benefits the manufacturing businesses without being constrained by either technical or economic dimensions.

Smart machines are used in factories as part of industrial automation to carry out manufacturing processes autonomously. With little assistance from operators the ability of computers and software to automate, improve and incorporate, the various components of the production system has become more important with development of microcontrollers and software.

So, with the relation between things, environment and people, if I say Internet of Things, it is Internet, things, people, environment, everything is connected. This is one of the case studies. I will now come to the next case study on the Rolls-Royce engine that we will be taking at the next lecture. Thank you.