Introduction to Industry 4.0 and Industrial Internet of Things
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Lecture - 17
Basis of Industrial IOT: Introduction

In this lecture, and few others to follow, we will be going through some of the basic concepts of industrial IoT or IIoT. In this lecture, specifically, we will go through some of the introductory motivating concepts, behind industrial IoT and how we can have a basic setup of industrial IoT in the lab scale. So, we will go through these different concepts to motivate why Industrial IoT is required.

So, at the outset let us consider different industrial application domains. Domains such as manufacturing industries, agriculture, mining, transportation and logistics, healthcare, and so on. So, there are different application domains and accordingly there are lot of industries, who cater to these different domains.

So, they have their own different industrial processes and we have gone through the basic concepts of different industrial processes and how these processes can be improved with the help of IoT in the previous lecture. So, what needs to be done is we need to really understand that how industrial IoT solutions can help in improving the overall efficiency of these different processes.

So, at the outset let us consider a few examples. Examples of let us say to start with mining industry in different mines. For example, coal mines there are different processes, that are there, mining processes that are there, which can monitor and prevent different events from happening.

So, for example, it is quite common in coal mines to monitor the gases the different gases that are formed in the mining process. For example, there are different gases such as methane different other gases. For example, carbon dioxide, carbon monoxide, and many others, which are basically formed in the underground mines in the mining process. So, these gases we will have to be detected and it is very important to detect these gases, because many of these gases can pose as hazards, because for example, methane. Methane is a highly inflammable gas, as most of you already know carbon dioxide or carbon monoxide can also cause fatalities. So, these gases are very harmful gases like this there are different other gases that are there. We need to it is very important to it to ensure that in the mining process in an in coal mines particularly to monitor continuously monitor the level or the concentration of each of these gases that are being produced.

So, gas monitoring under in the underground mines continuously in real time is very important and accordingly if the concentration of a very harmful gas has increased beyond a certain threshold or a limit, then it is very important to generate alerts for the mineworkers or at the control centre and accordingly take steps such as evacuate the mine workers or whoever is there underground. So, that is one application like this there are different other applications in underground mines for example, strata, a fall monitoring. So, let us say that you are mining the coal out and the strata or the roof above the area from where the mining has been conducted that might collapse. So, that monitoring of that roof above the extracted portion is very important. So, the roof might collapse and cause a hazard to the mining workers. So, like this there are different other applications also. So, all these things for doing all of these things it is very important to use these different technologies like IIoT or Industrial IoT. So, Industrial IoT applications for gas monitoring underground mines is very important application.

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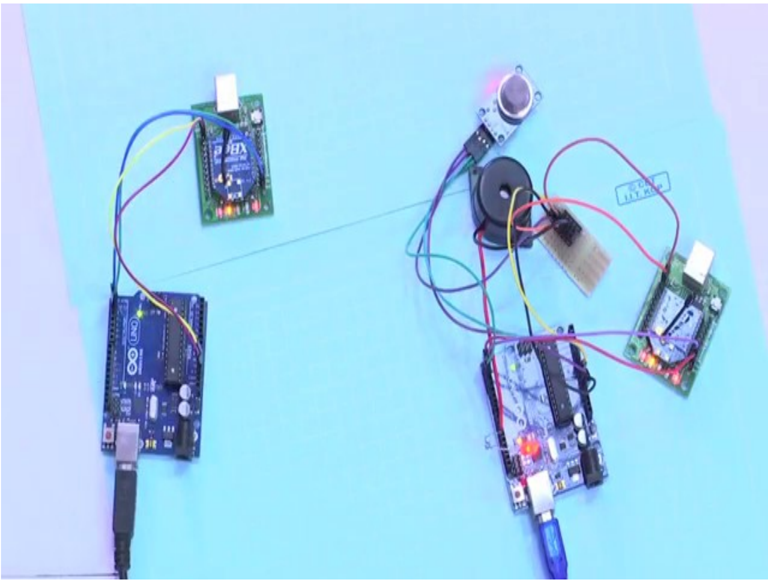

Let us look at a very simple application of gas monitoring, using different sensors and IIoT technologies. So, at the outset let me just tell you one more thing that. So, when we talk about a IIoT. So, Industrial IoT means its kind of a specific type of application of IoT for addressing the different industrial issues.

So, here I am talking about mining industry, gas monitoring, and so on for another industry there are different other issues, but at the core of all of these it is about sensing, actuation, networking, connectivity, processing and so on. Let us look at one very small kind of application of gas monitoring. This is a gas sensor which can detect few gases.

So, this sensor can help you in doing it then we have an actuator, which is a buzzer. We have kept this buzzer, because we want to show that if the concentration of the gases is increased, then the sensor is going to pick it up and this buzzer is going to buzz showing the actual concentration of the gas, the LPG gas, but it could be any other gas as well it has increased.

So, this is the one which will do it and then we have. So, this sensing is done over here by this sensor and in then this sensor sends this data and some processing is done over here by this microcontroller unit that we have and thereafter this data is sent from one site to another site. So, let us say that this is one site and this is another site. So, this is sent from one site to another site and for this we have two different communication modules over here this is one and this is another.

Let us say that, this is the sender and this is the receiver. This receiver unit is going to sense, going to collect all these data that are sent by the sender unit, connected to the sensor and that will be picked up over here at the receiver and from there it is going to be sent to the control center.

So, this is going to be sent to the control center from where the monitoring of the gases are going to be done. Let us take a look at this example. So, let us say that we bring some concentration of LPG gas over here as you can see that it has alerted. So, the sound came. So, this buzzer has buzzed.

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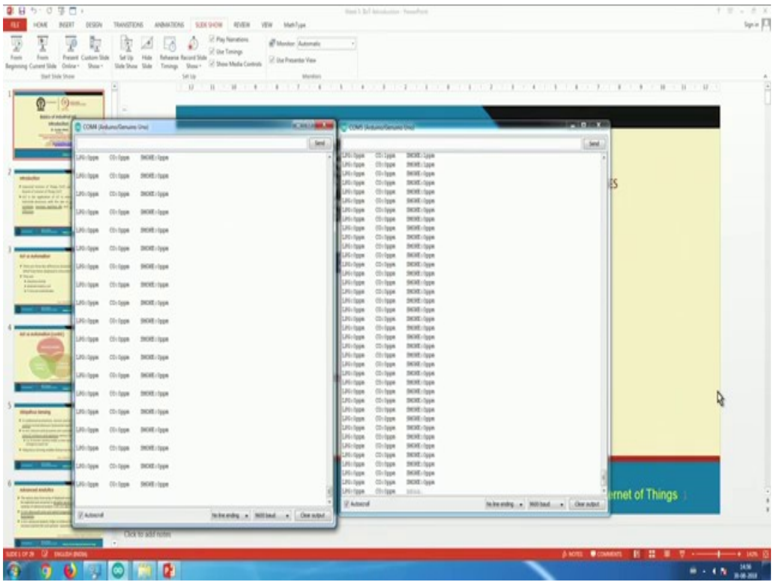

So, if we look at this data this is basically the sender as you can see over here detected some smoke or whatever some gases some carbon monoxide gas was detected and then it is sending it and the receiver is receiving over here.

So, this is basically the receiver over here as you can see it is showing that it had received these. So, over here as you can see on the top. So, we can try it out once again. So, you can see that this is the sender, which is showing that some gases have been detected and this is the receiver, which is also receiving those values. Let us assume that this is the control center from where this concentration of these gases are being detected and this is how this monitoring can be done. This is a very simple kind of application showing how gas monitoring can be done not only in mining industries, but also in other industries as any other chemical industry or whatever where gas monitoring is also very important, like the gas monitoring application for underground mines. Let us consider another application of IIoT. Let us consider the healthcare industry, for example, in hospitals, there are different patients, health care professionals such as doctors, nurses. It is often very much important to monitor the condition of the patients continuously in real time and so on.

So, with the existing technology the traditional technology it is difficult, because traditionally what has to happen is the doctors and nurses or other healthcare professionals we will have to periodically visit the patient. Then monitor the health of the patient that is one. Better than that is, at the word site of the patient there might be some different medical devices which might be also equipped with different sensors, but those sensors are standalone sensors, they are typically not connected sensors and all they can do is they can give the they can show the value the physiological parameter value that is being monitored for the patient.

So, with the advent of IIoT and IoT, in general, it is now possible to continuously monitor the health condition of the patient. So, over here like the previous example, I am now going to show you two very fundamental sensors that can be used for monitoring the health of the patient.

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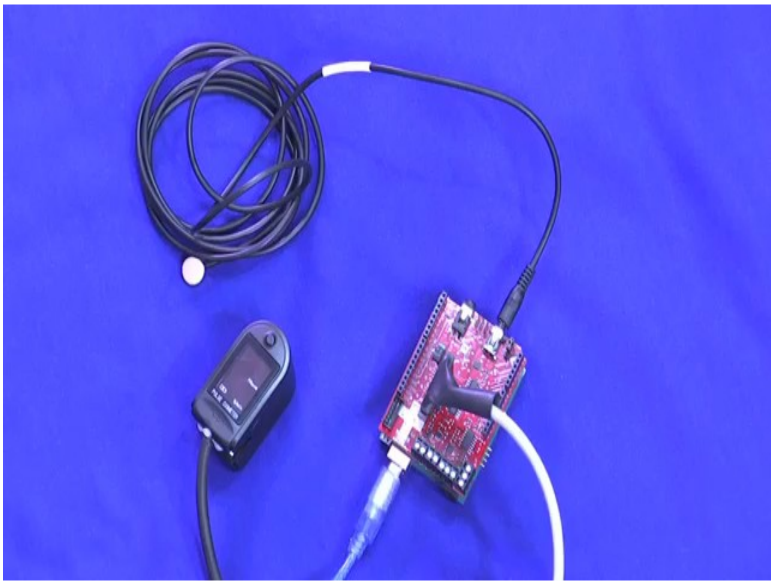

Here what you see this is the temperature sensor this is the body temperature sensor that is there and this is something known as the pulse oximeter. So, pulse oximeter, basically measures the oxygen saturation in the blood of the patient, as well as the pulse rate.

These two sensors have this picked up, you can use different other physiological monitoring sensors to monitor the condition of the patients and the advantages is, as I was telling you that autonomously in real-time continuously the condition of the patients can be monitored and alerts can be generated for the doctors, if there is some criticality in the health condition of the patient.

So, now you can understand that this is a very useful tool that can help you achieve it. So, how it is done in this case? So, this body temperature sensor let us say that, it is fitted with a patient. I have just pressed it to show the body temperature.

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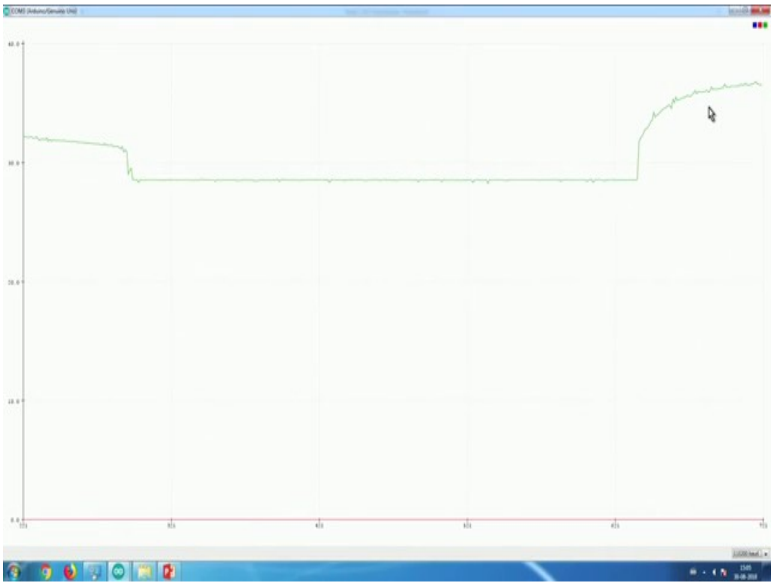

So, what I have over here as you can see on the screen as you can see over here the temperature value it is increasing. This is the temperature reading, this is continuously increasing and let us say that, this is at the doctors panel for one patient or for many patients also this thing can be extended and can be scaled up to monitor the health condition of different other patients. So, this is the temperature plot and likewise this pulse oximeter that is there.

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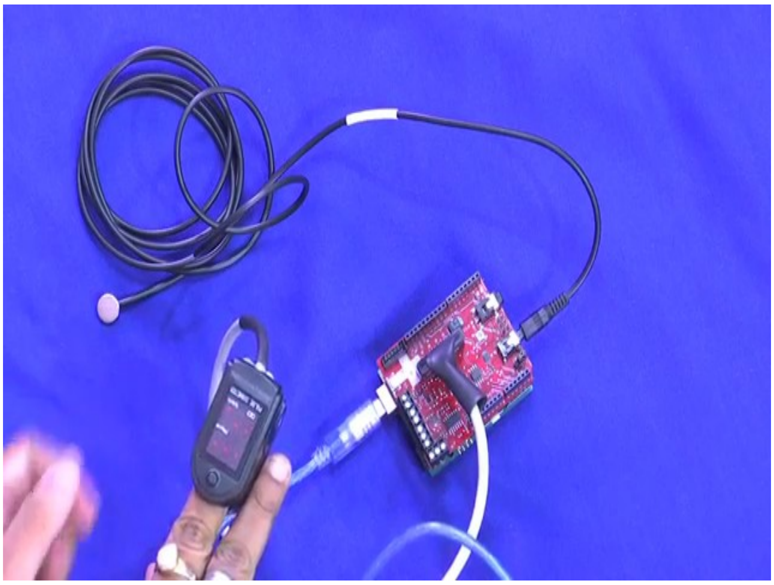

I could use it to show you that, a patient could be fitted with it like this.

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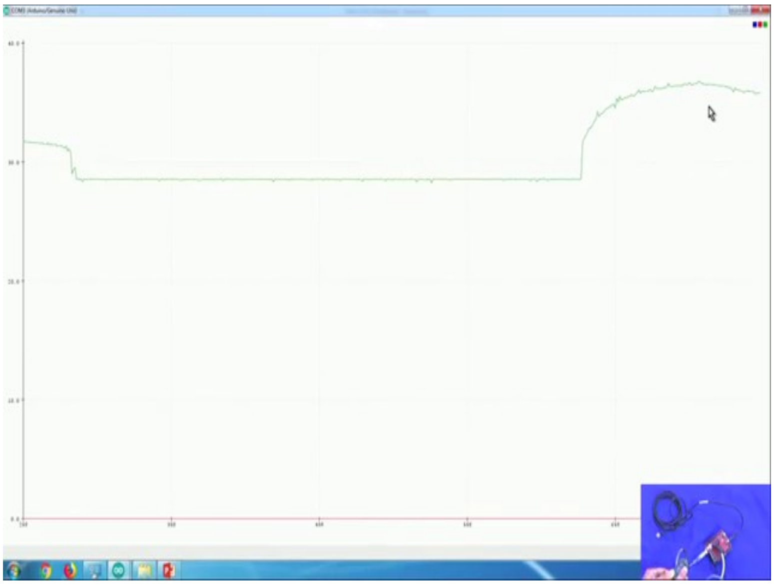

Then on the screen I should be able to get the value of two things. So, I have now put the pulse oximeter sensor put my finger into it and I just told you that the pulse oximeter sensor helps in measuring two things, one is the oxygen saturation in the blood and the other one is the pulse rate.

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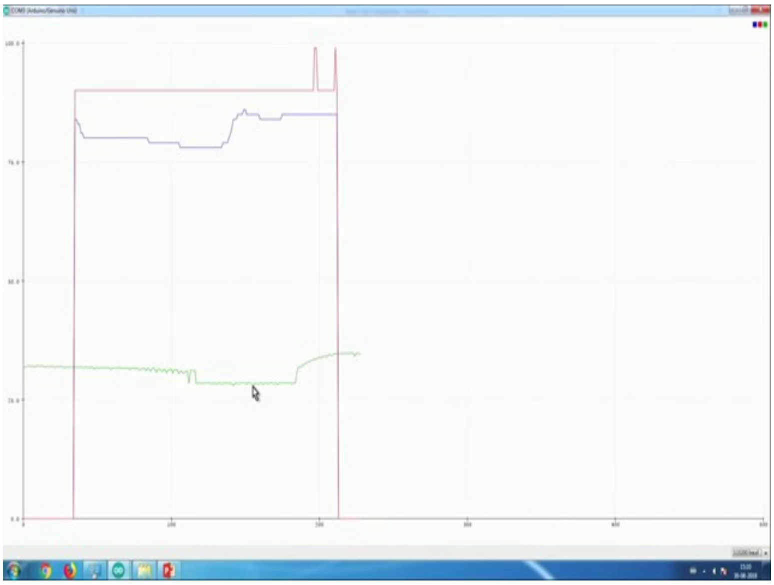

So, now looking at the control view.

So, as we can see over here, this is the blue one is basically the heart rate and this is the oxygen saturation in the blood and as you can see over here these two values are gradually getting plotted over time, this temperature value is still low, because I just left it out, but I could be again putting it on my finger for measuring the temperature and the temperature value the body temperature value is increasing.

So, this is an application of different healthcare physiological monitoring sensors, which can be used in the health care centers such as hospitals, for continuously monitoring the health condition of different patient by the doctors and nurses.

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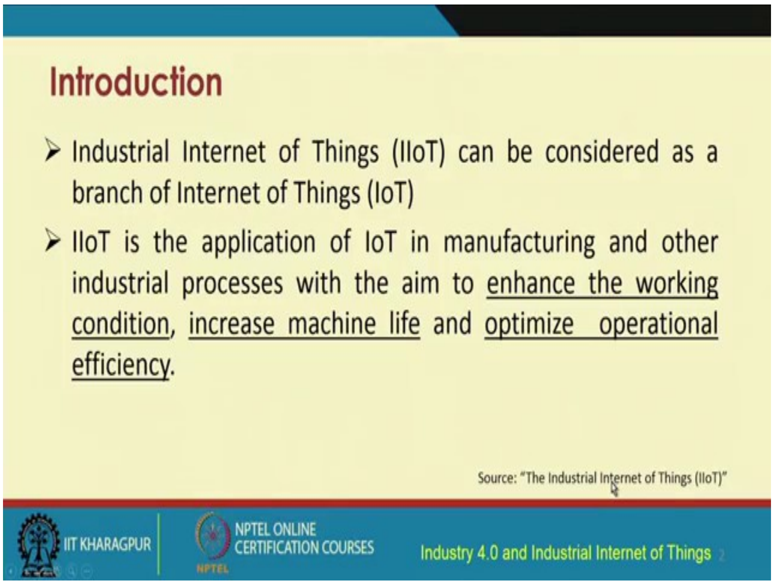

Let us and look at the details of Industrial IoT. So, as I told you at the outset that Industrial IoT is about the use of Internet of Things for serving different industrial applications. So, industrial applications could be many such as manufacturing, agriculture, and healthcare.

And so, basically IoT for industrial applications is what IIoT talks about and the overall idea is to use this IIoT for increasing or enhancing the working condition in the industries such as the safety, safety of the workers in the industry, the ergonomic conditions in the industry and so, on safety ergonomic issues and. So, on increasing the machine life, optimizing the operational efficiency, and many others. There are many different uses of Industrial IoT.

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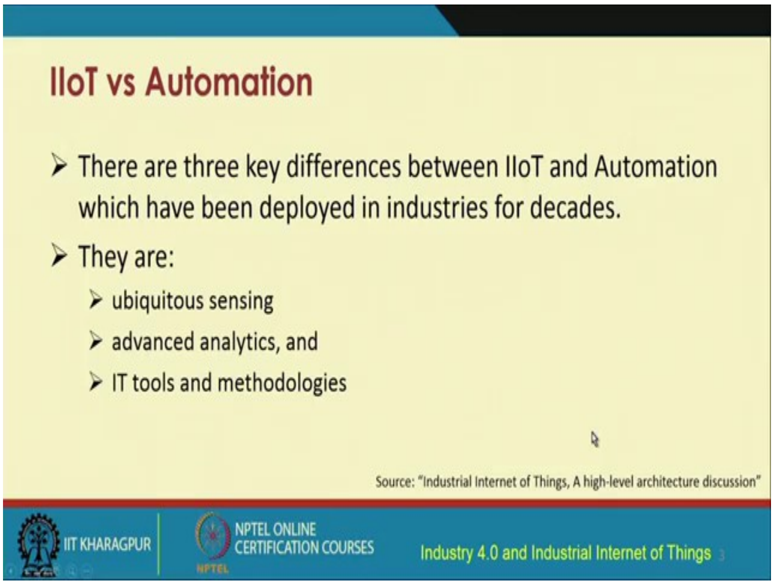

So, IIoT and its primitive have been there before as well and in this new context that IIoT become more interesting. IIoT is primitive is that automation that has been there since long in the industry, since decades, it has been there industries have been using automation, since long. These are the key differences between IIoT and Automation. These differences are with respect to three different parameters with respect to sensing, with respect to analytics, and these IT tools and methodologies that are being used.

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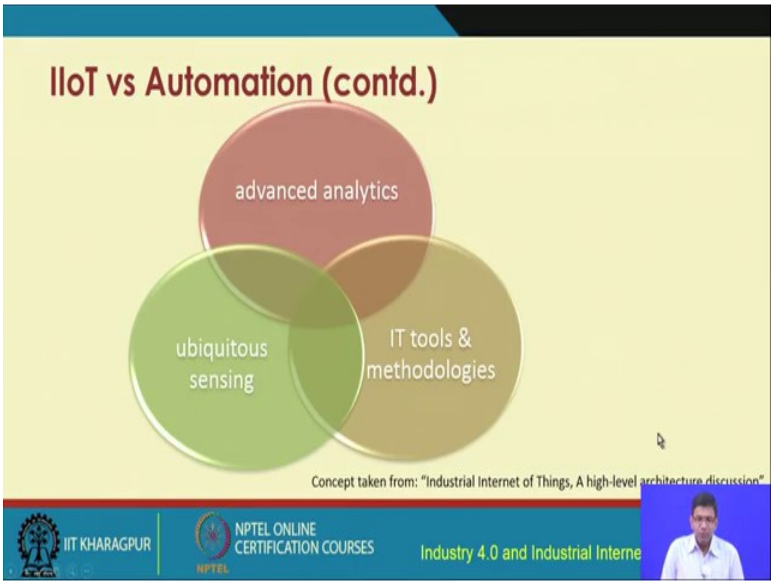

So, let us take up one by one each of these. So, these differences with respect to sensing analytics and methodologies are with they have their own different facets.

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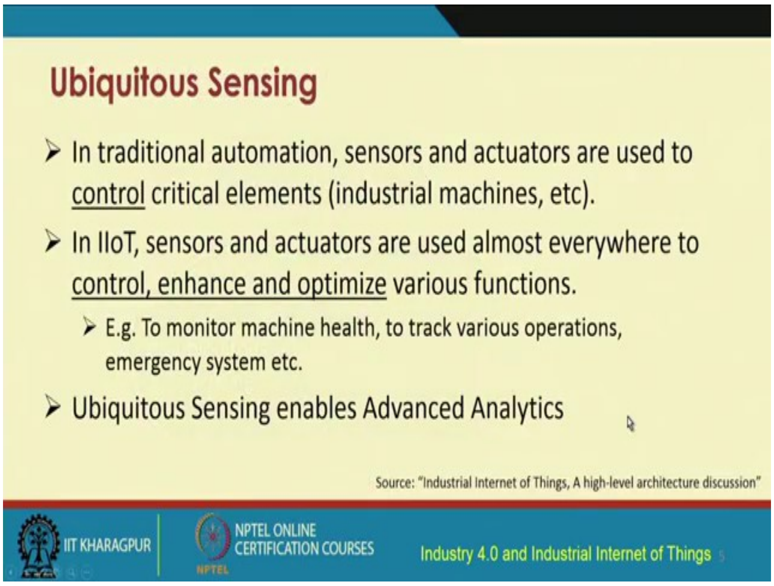

So, let us start with the ubiquitous sensing first. So, in traditional automation before IIoT became popular, sensors and actuators have been used to monitor the condition of the machines these have been there and it is not new. Different sensors are used to monitor the critical elements such as whether a particular component of a machine is functioning properly or not.

And if it is not or even if it is to actuate certain other components and that has been there it is not new, then in IIoT sensors and actuators have been also used everywhere to control, enhance, and optimize various functions. Those things have been there since long, but what has been what has come up to be new is to be able to monitor the condition of different machines at the same time and having each of these machines share the data between themselves and to some central point is something that is newer. So, this whole packaging is new.

So, this ubiquitous sensing is useless basically in the IIoT context, if we are not taking advantage of the data and running some advanced analytics on top.

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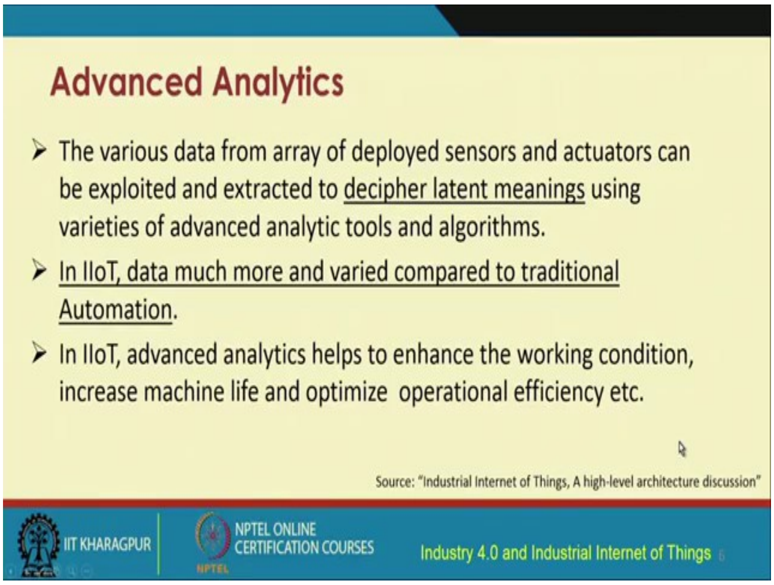

Now, with respect to analytics in a standalone fashion have been there, but in the context of IIoT, we are talking about, a large volume of data coming from different machines in the same industry and different other industries and locations. And then getting a holistic view of it and all these things are possible due to this connectivity issue, that I told you the earlier.

So, because of this connectivity between these different machines, different locations. This volume of data and running different analytics intelligently to decipher the latent meaning of these different activities that are being carried on and the condition of these different machines, that are operating in the industry, this is possible now.

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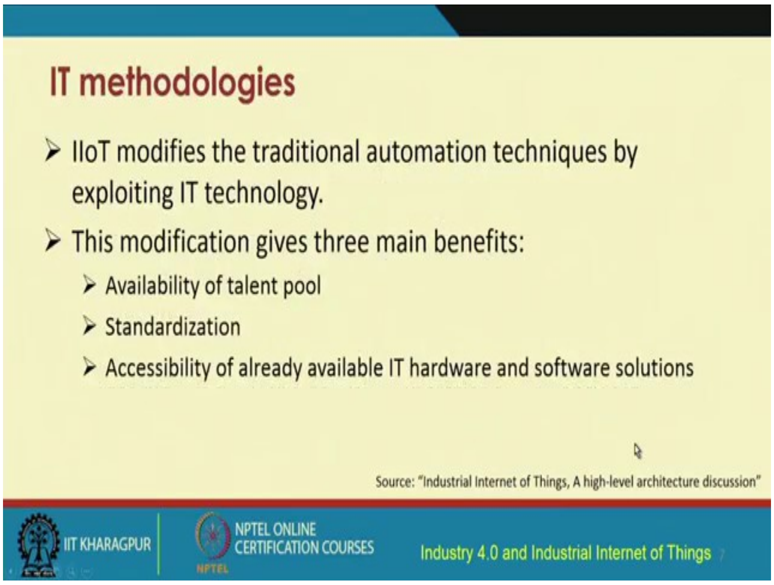

With respect to these IT methodologies, automation is solely dependent on IT and this has been there again since long. IIoT basically modifies the traditional automation techniques by exploiting the IT technology and particularly with respect to the networking aspect, the communication and networking.

This modification gives three main benefits availability of talent pool, standardization, and accessibility of already available IT hardware and software solution in all these industries, and as I told you these IT hardware and software has been there since long and we are not talking about anything new now, but this connectivity is new.

Connectivity issue and scaling up earlier everything was die being done individually in these machines in a standalone fashion now we are talking about this overall networked, networking among these machines, among these IT infrastructure, with the help of packaging, with sensors, actuators and that is what has become the newer concept in the context of a IIoT and it is automation, the traditional automation plus network, sensing actuation, and decision making and I would define IIoT to be this way.

IIoT is the traditional automation with the help of standalone computers, computing devices and plus added to that sensing, actuation, and decision making, in a connected manner.

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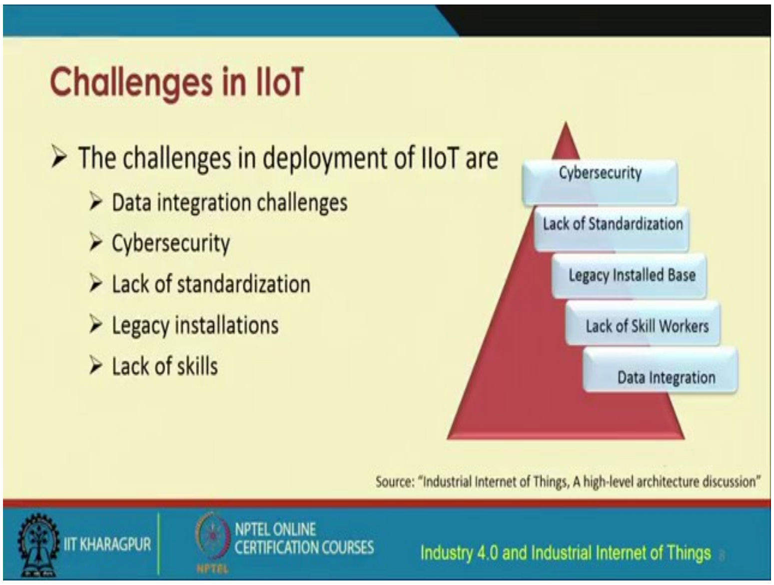

So, there are different challenges in the deployment of IIoT. There are data integration challenges. So, we are talking about large number of machines. These different machines have their own heterogeneity in place, heterogeneous data and integration of these varied types of data coming in high volumes and large different types of varieties.

These the integration of such data is a huge challenge, in the IIoT context, and this was not there earlier when the traditional automation was there in the industrial plants. Cyber security we have talked about it earlier in the context of Industry 4.0. So, cyber security is very important because now we are talking about a very connected world, where a world where different machines are connected between themselves and machines to people, machines to humans, humans to humans, and so on.

So, much of connectivity is there that it is quite likely that we are going to introduce some vulnerabilities in the overall network and making it possible for different types of attacks, newer types of attacks to be launched. The third one is lack of standardization in IoT, in IIoT, and so on. There are no there is no single standard that governs IIoT that governs IoT, there is no single standard. There is lack of standard. There are some standardization efforts disparate wants that are going on globally, but there is no single standard.

So, this basically is also a huge challenge in the context of IIoT. The next one is legacy installations when we talk about industries. Industries have huge legacy machine base and these machines have been operating successfully since decades, now with the incorporation of IIoT what is going to happen is you have to have support for these newer technologies and newer machines being procured, with the installed new technologies supporting IIoT and also having that integrate with the legacy installations.

And the last challenge is basically, the lack of skills, this is a new technology, holistically all the bits and pieces have been there, and we still do not have enough skilled manpower in these different industries, who want to adopt this new technology of IIoT.

So, because of this lack of skilled manpower, there are different problems that are possible. It is possible that without the lack of skills, vulnerabilities might be put in into the system, and which might attract different attackers who can launch different attacks and cause harm to the overall system thereby resulting in loss to the business, who adopted this IIoT technology.

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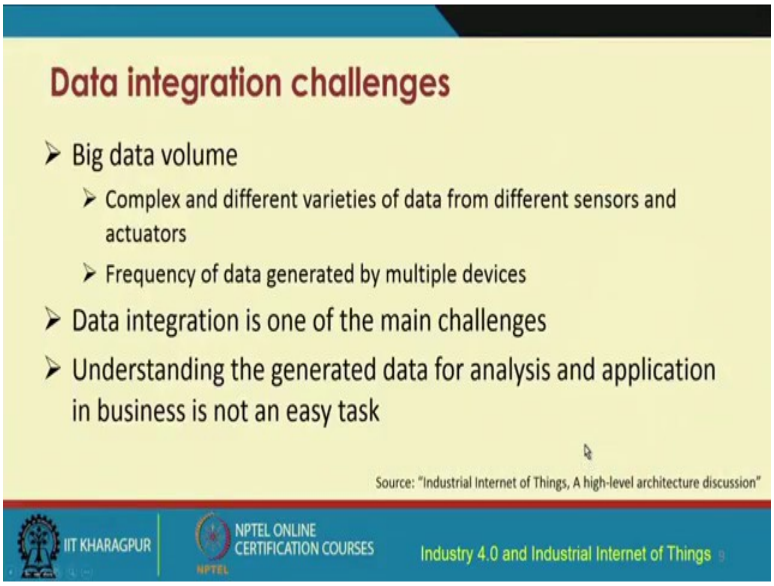

There are data integration challenges with respect to the volume of data, that is coming in, we are talking about the complexity of the data, the variety of data, that is coming in, a huge volume, in large velocities continuously these data coming from these different sensors and actuators. So, to manage this data, to analyze this data is a very herculean task. So, that is why this adoption of IIoT is also very non-trivial.

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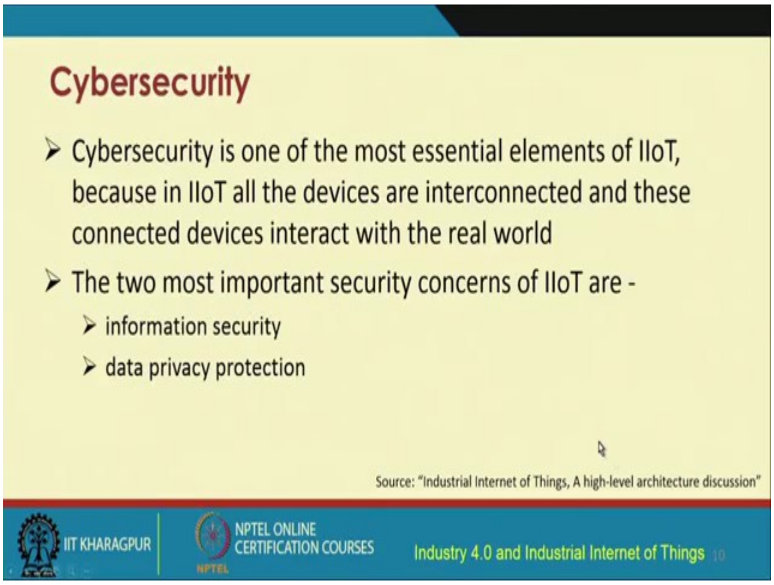

Cybersecurity is something that I have already told you, we are talking about a well connected internet worked world of different devices, machines working in the industry and once we have set up this network, it is quite possible that we will introduce different security issues. Issues of vulnerability, introducing different security issues and attracting different types of attackers, this is quite possible, and the other very related issue to the cyber security or information security or system secure, is the privacy issue.

So, here we are talking about collecting lot of data autonomously from these different machines. So, it is quite possible that one would be concerned about the privacy of the individuals working in these different factories. The privacy of the data that is collected from these individual machines autonomously. So, the privacy of the machines, individuals working in the industry, this also becomes a very important concern along with information and system security.

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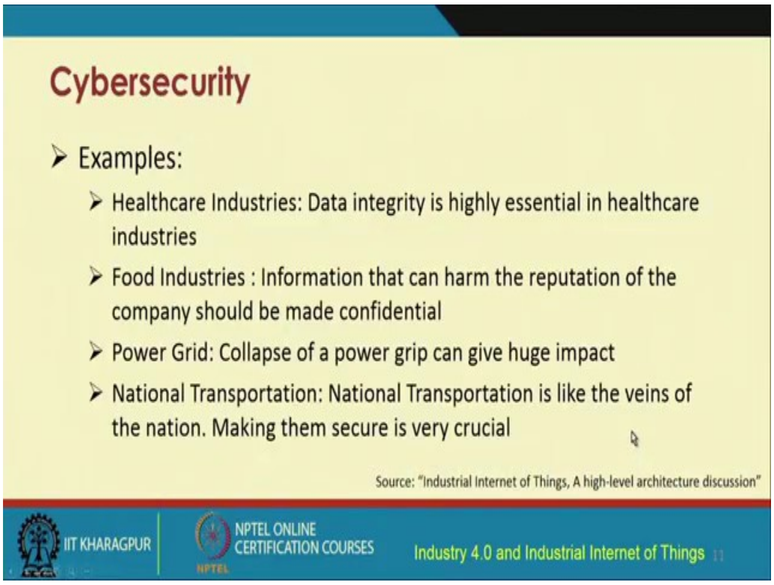

So, for example, in the healthcare industry data integrity is highly essential.

So, nobody should be able to tamper with the data, actual patient data, that is being collected. So, obviously, in healthcare industry from this particular viewpoint security is very important. In food industries also if somebody plays around with the data that kind of attack can harm the reputation of the company and that kind of data should be made secured, should be made confidential. In the power sector like power grids. It is very easy for one to have a grip of the power system and cause a huge impact like having a launching some kind of attack which is going to bring the system down and having a large downtime.

So, these kinds of attacks are possible. Similarly, in transportation as well transportation typically highway transportation is sort of the vein of any nation. So, securing this turns into the IIoT infrastructure in this transportation domain is also very crucial.

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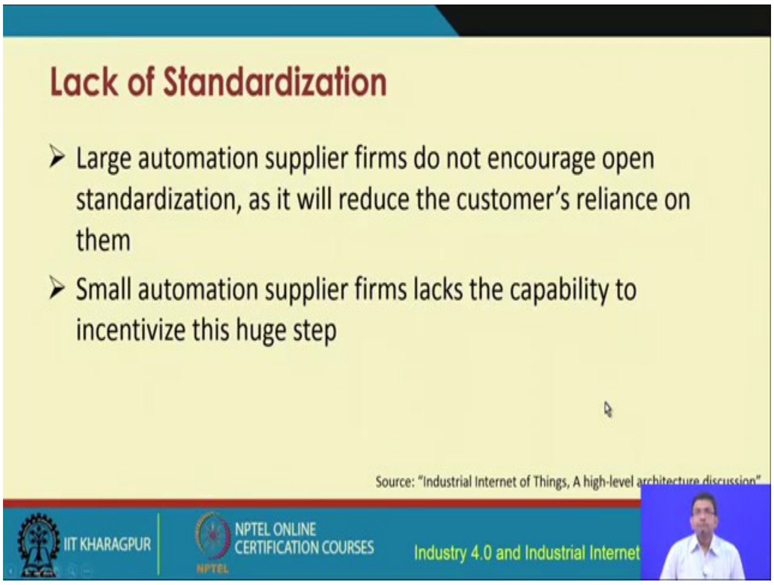

So, there is lack of standardization, as I was telling you earlier. So, the large automation suppliers firms do not encourage open standardization.

So, they will need they would encourage to have their own different, customized solutions and that also has an age in terms of business profits and so on. And this whole issue of standardization will reduce the customers reliance on these different equipments that are collected. So, small automation supplier firms basically lack the capability to incentivize this huge step.

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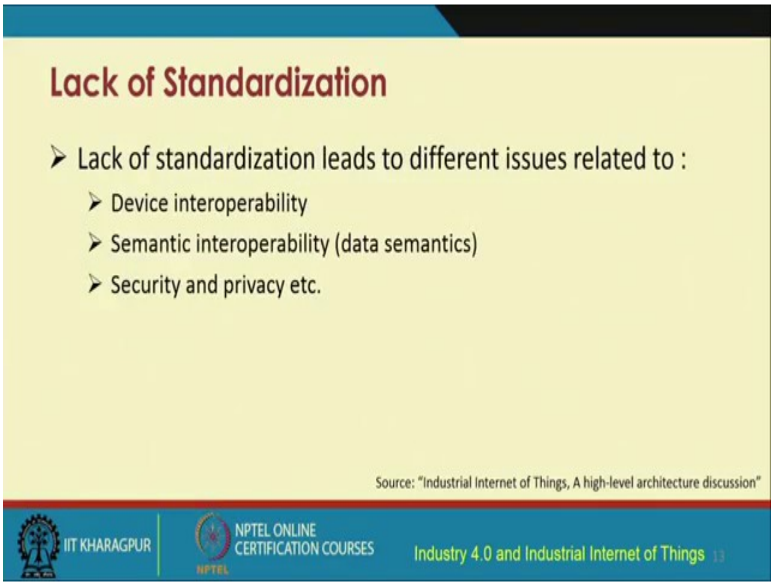

Lack of standardization leads to different issues related to device interoperability, semantic interoperability, device interoperability is understood. So, different machines supporting different IoT devices they need to talk to each other all and they have been made by different vendors.

So, device level interoperability is understood, but what is the semantic interoperability that we are talking about. Semantics means, meaning. So, these different devices talking different languages they should be able to talk to each other meaningfully, they should be able to understand what they are talking about. So, that is the semantic interoperability and; security and privacy issues and the standardization concerns are also very important, in this context.

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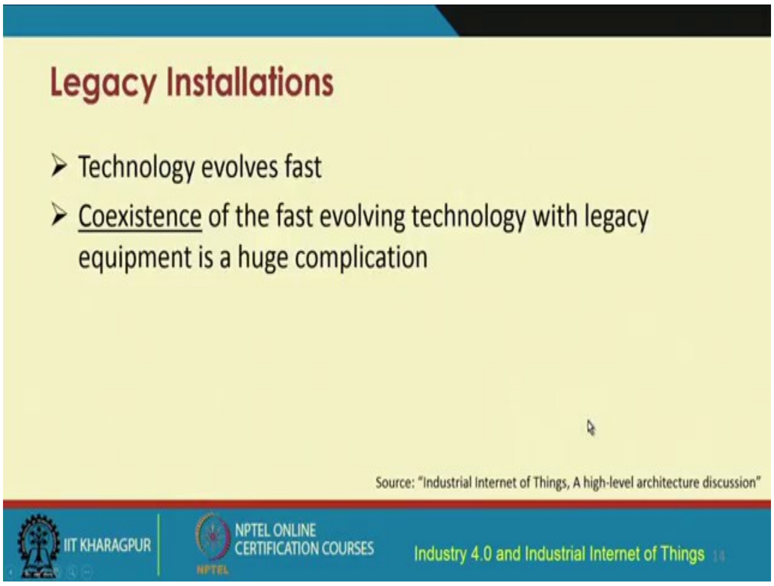

Legacy installations are a very crucial aspect to be considered. Technology is evolving fast, there are technologies in the industries that have been therefore, decades there are certain technologies that have there are more advanced than those legacy wants and there are some very new technologies that are adopted.

So, all these technologies should be adopted, the newer ones with that legacy ones should be all integrated together leave it without leaving any kind of vulnerability in the whole integrated system.

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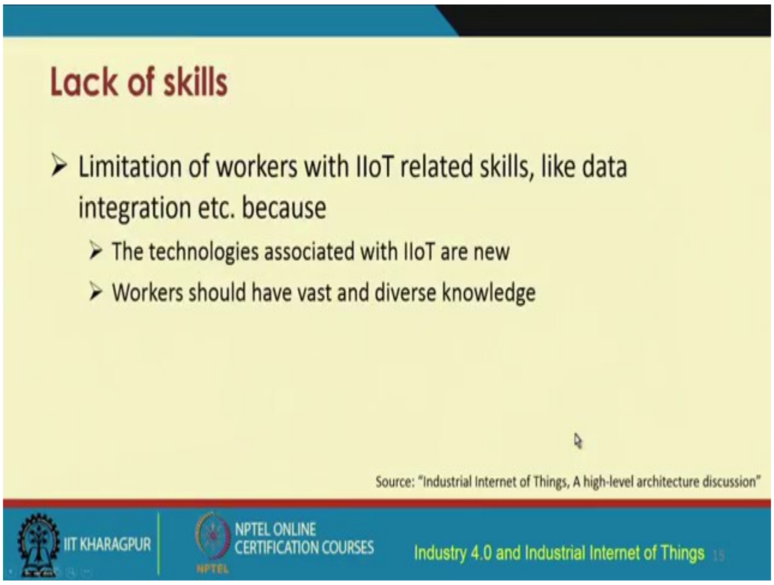

Lack of skills about a world of IIoT, it is a new technology. So, new technology means we have limitation of workers with IIoT related skills like data integration etcetera because these technologies are associated with IIoT and these new associated technologies these technologies are new in nature.

So, workers should have fast and diverse knowledge about these technologies.

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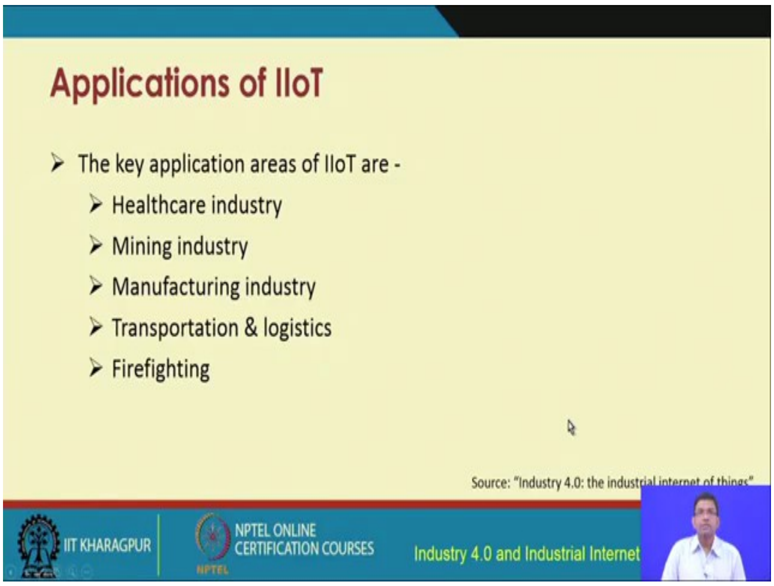

So, earlier at the very outset about the different applications of IIoT are in the healthcare industry, mining industry, manufacturing industry, transportation and logistics, firefighting, sewerage, smart cities and so on.

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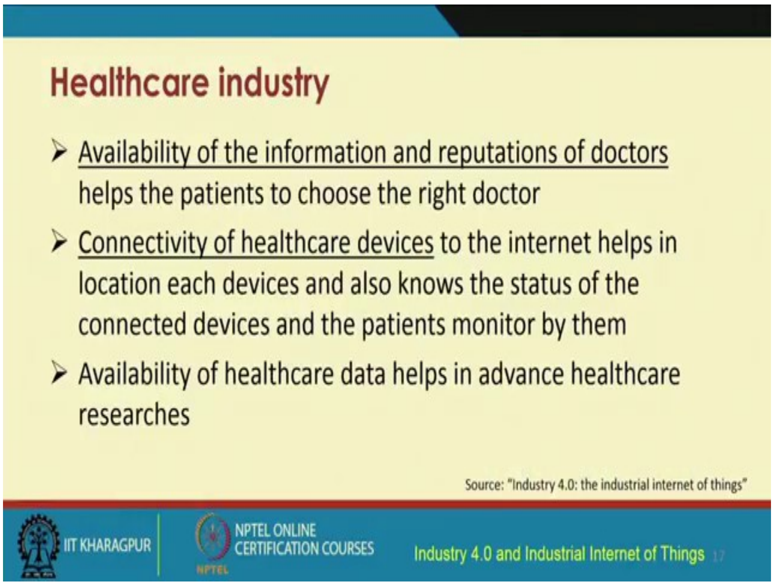

So, in the health care industry availability of the information and repetition of doctors helps the patients to choose the right doctor. Connectivity of healthcare devices to the internet will basically help you in doing it and this is what we had seen in a very small scale and application of IIoT in the healthcare industry.

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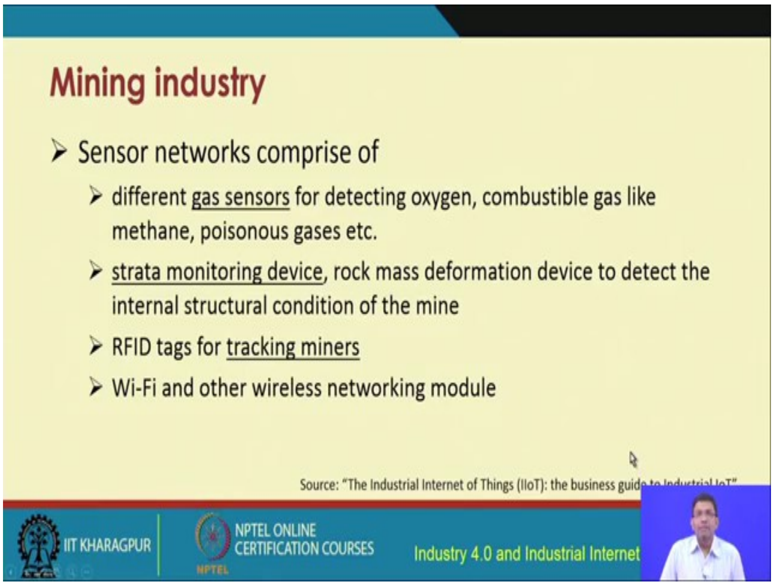

So, at the very outset I had given you the example of this temperature sensor and pulse oximeter sensor being used and through a connected network this data is sent to the control center for further evaluation, monitoring, and so on.

So, that is basically a very rudimentary form of application of IIoT in the healthcare industry. The mining industry also gas monitoring and the example that I had shown you at the very beginning gas monitoring in coal mines monitoring the level of what the concentration of poisonous gases like methane and carbon monoxide. So, this can be possible with the help of a IIoT-based technologies.

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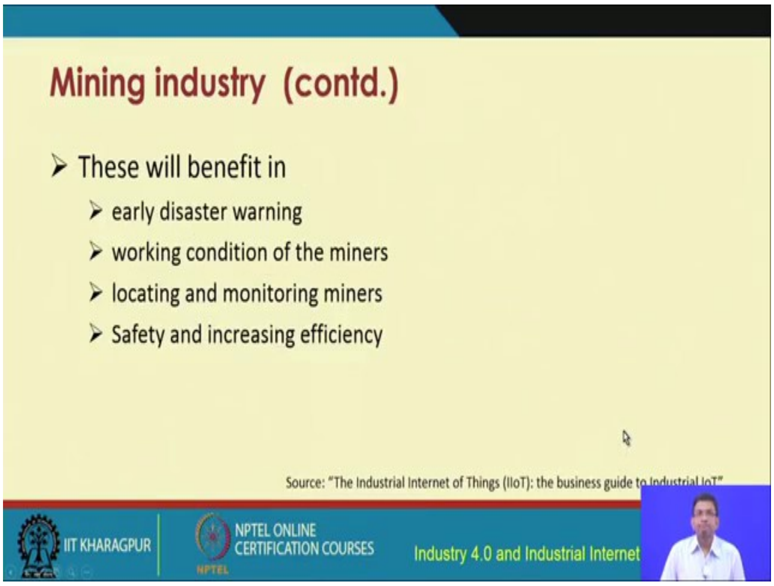

So, the adoption of IIoT technologies in the mining industry we will benefit in terms of having early with disaster warning, working condition of the miners can be monitored in real time continuously, and so on.

Locating and monitoring the miners during normal times and during emergency situations let us say if there is a mine fire locating and monitoring the miners is a very important problem and IIoT can help in doing. So, in an efficient manner safety and increasing efficiency in the mining industry is another benefit that will come out from the adoption of IIoT.

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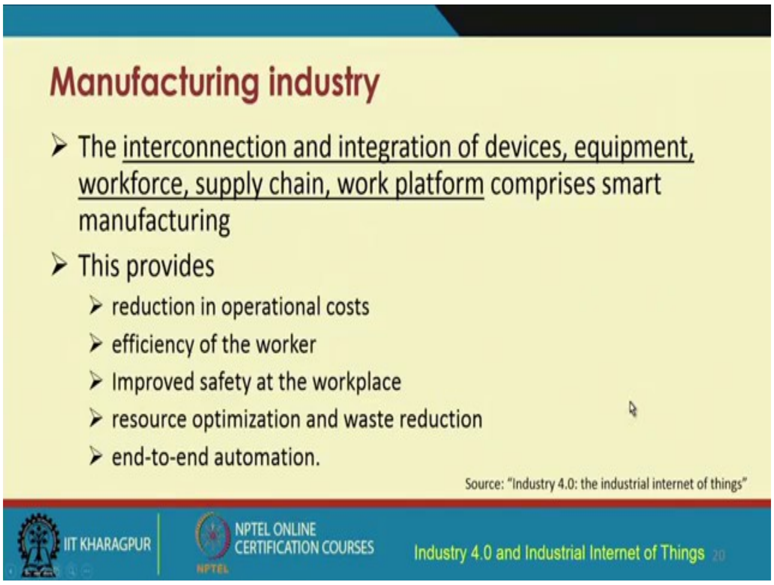

In the manufacturing industry, an interconnection and integration of different devices, different machines, equipments, workforce, supply chain, work platform.

So, together the integration of all of these things would make a smart manufacturing platform that will provide reduction in operational costs, efficiency of the workers can be improved, improved safety at the workplace, resource optimization, waste reduction in the industries, and end-to-end automation, these are all the different benefits of interconnection and integration of all these devices in IIoT, in the manufacturing industry.

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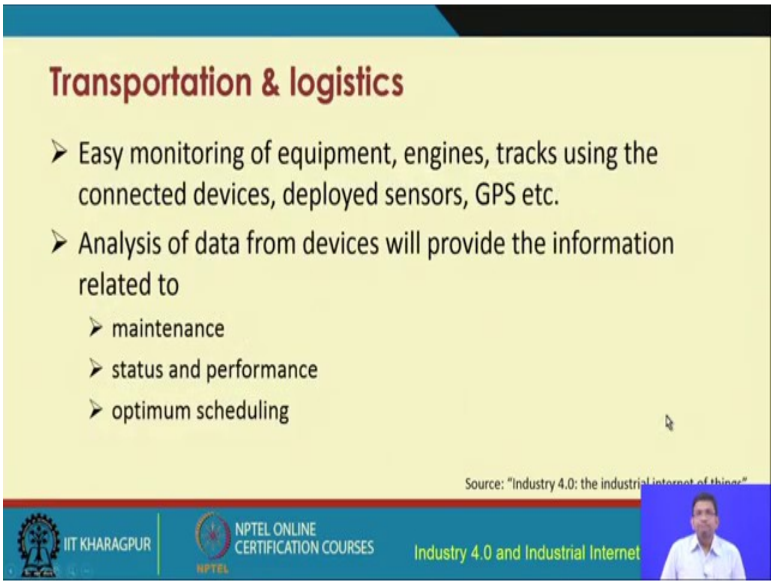

Transportation and logistics likewise it is possible to easily monitor the equipments, engines, tracking using the connected devices, deployed sensors, gps. So, this kind of tracking devices, tracking sensors and can be used to track for example, where the different trucks are in a particular logistic application. The trucks that are there on the highway at which position these different trucks are how much time they are resting on the highway and whether they are having adequate sleep or not their drivers of these different vehicles whether they are having adequate sleep or not and whether the condition of these trucks.

This is a just an example that, the condition of the trucks whether these conditions are good enough for carrying on further or there is some kind of maintenance activity that will need to be carried on, like this is the scheduling optimum, scheduling of these different vehicles could also be performed with the help of IIoT technologies.

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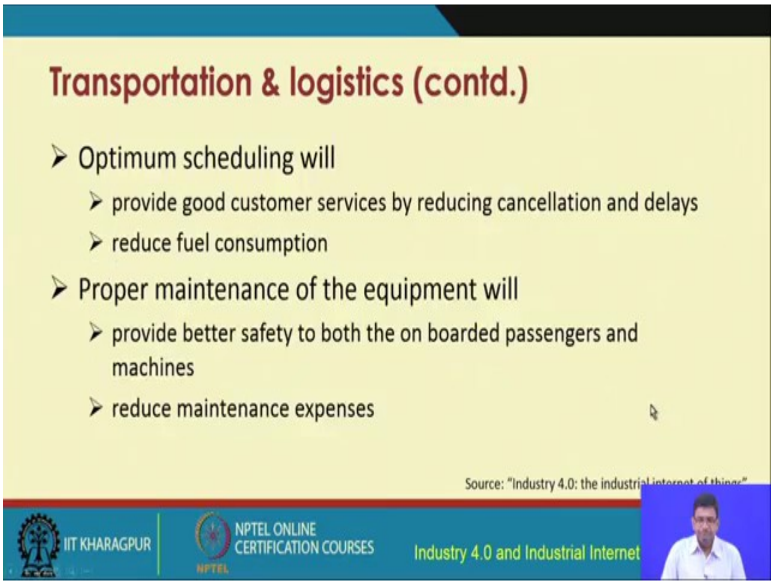

So, optimum scheduling we will provide good customer services by reducing cancellations and delays and reduce overall fuel consumption. So, proper maintenance of the equipment, we will provide improved safety to both the onboard passengers and the machines and thereby reducing the maintenance expenses.

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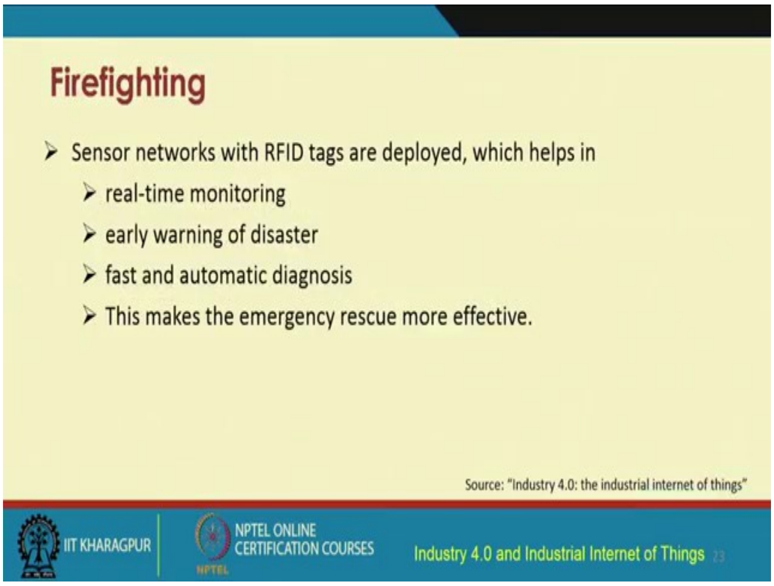

Firefighting also attracts lot of use of different IIoT technologies sensor networks. With RFID tags, real-time monitoring of fires in the industrial workspace or even in different other areas such as different buildings, in homes and so on, and early warning of different incoming deserters can also be possible. With the help of the use of IIoT in the firefighting application domain.

The last thing is the automatic and fast diagnosis of these different faults, that can happen, can also be performed efficiently and promptly, with the help of the use of IIoT technologies.

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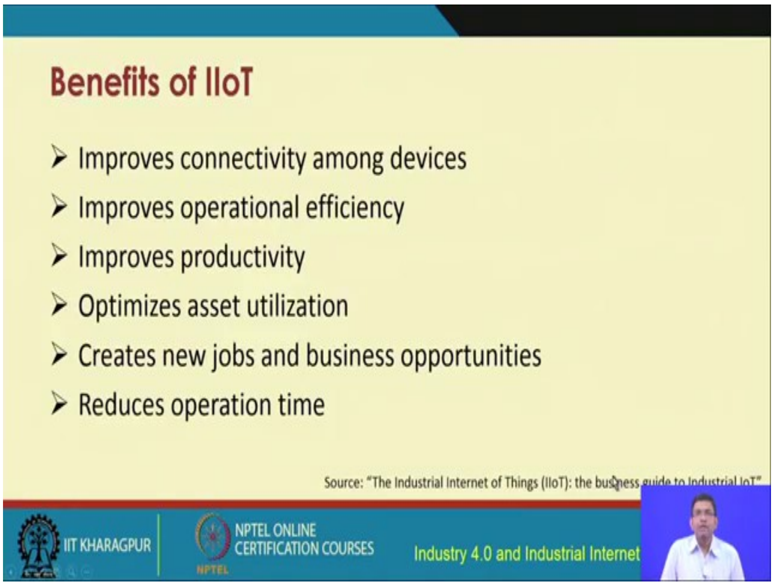

So, these are different benefits of IIoT improving connectivity among devices, improving operational efficiency, improving productivity, optimizing asset utilization, creating new jobs and business opportunities, and reducing operation time, these are the different benefits of the adoption of IIoT technologies in the industry.

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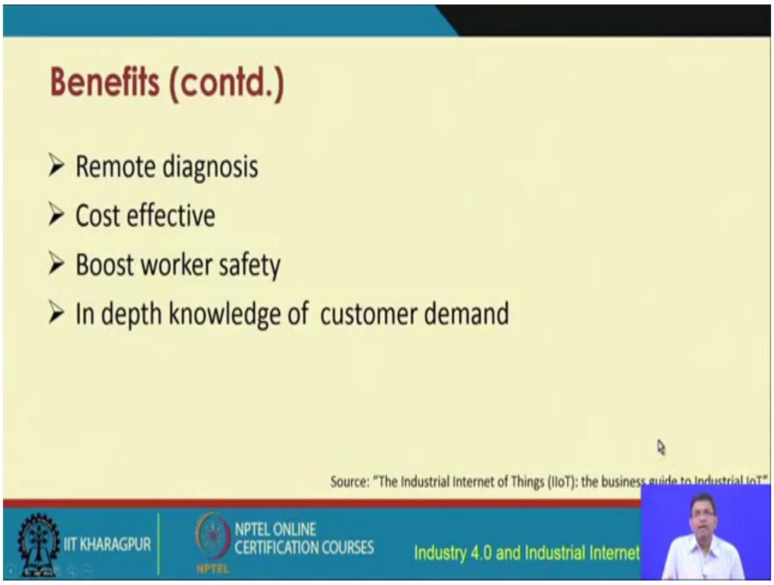

So, there are different other benefits as well remote diagnosis then remote diagnosis of what? Remote diagnosis of machines, cost effectiveness, boosting workers' safety and this is worker safety ergonomic issues. IIoT technologies have found lot of applications there are new number of different projects that are running on worldwide to improve IIoT to improve worker safety in the industries, with the adoption of these different IIoT technologies.

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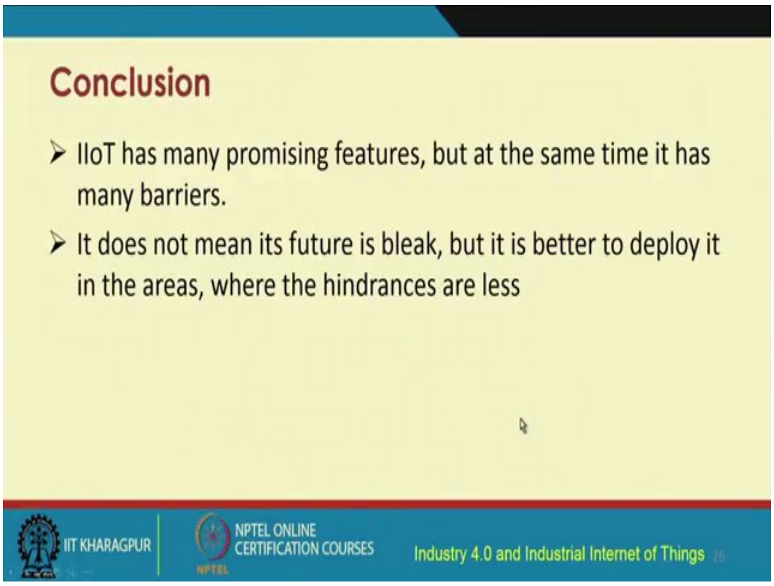

So, to conclude IIoT is a very promising technology, which has different attractive features, but at the same time there are many barriers that will have to be crossed, and it does not mean in the future. These barriers are many different challenges to be overcome. It does not mean that the future of IIoT. In fact, the adoption of IIoT is increasing day by day continuously in all industries in India and throughout the world.

And so, basically it is gradually, every day the adoption of IIoT technologies is increasing and it is quite expected that in the future it is going to increase even further and we would be able to see a very well connected world, where different industries are connected, advanced analytics are being carried on to get to mind in lot of data to get lot of insight about the different aspects, that these different industries are addressing.

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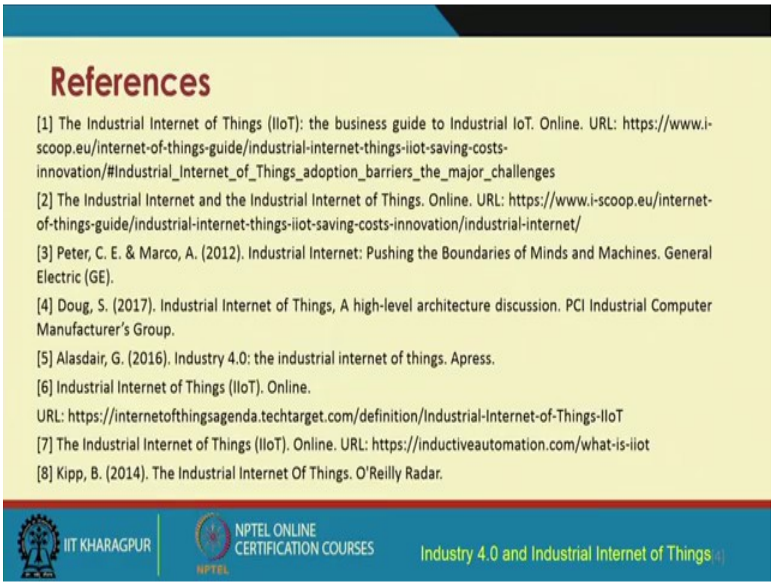

So, these are some of these references for you to go through if you are interested to dig further into these basic issues and with this we come to an end.

Thank you.