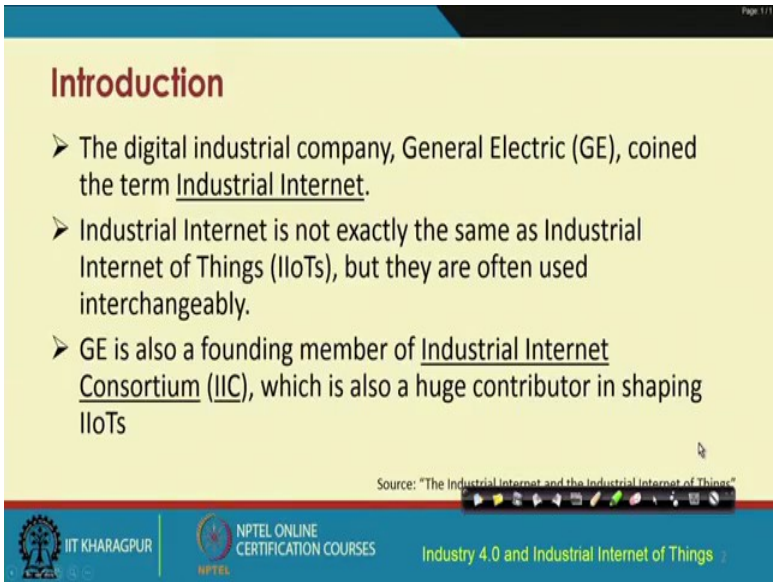
Introduction to Industry 4.0 and Industrial Internet of Things

Prof. Sudip Misra
Department of Computer Science and Engineering
Indian Institutes of Technology, Kharagpur

Lecture – 18
Basics of Industrial IOT: Industrial Internet Systems

In this lecture, we will go through some of the basics of Industrial Internet Systems. So, industrial internet systems is something, that has also become very popular, in the recent years, along with Industrial IoT. So, basically these two efforts although are quite similar in nature their origin is bit different.

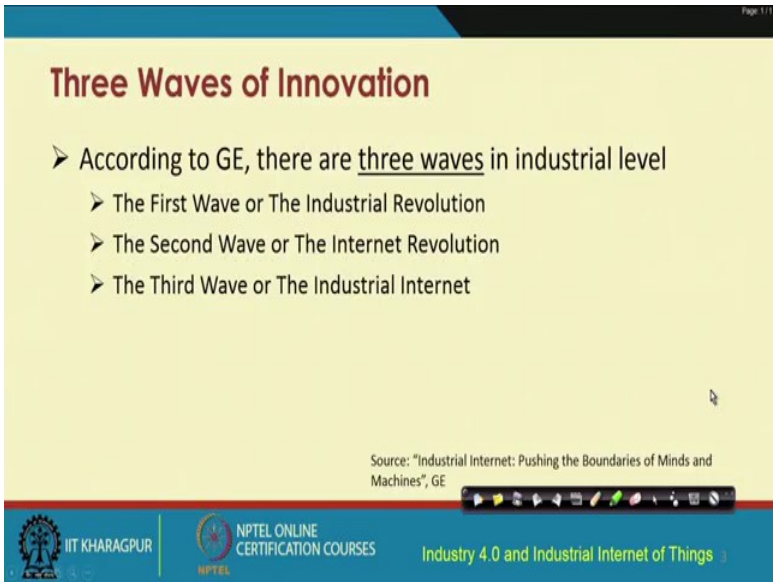
(Refer Slide Time: 00:45)



So, industrial internet the origin is basically linked to the digital industrial company, General Electric, who coined this term industrial internet. And it is not exactly like the industrial IoT that we discussed in the previous lecture, but is often commonly used interchangeably by people in the industries.

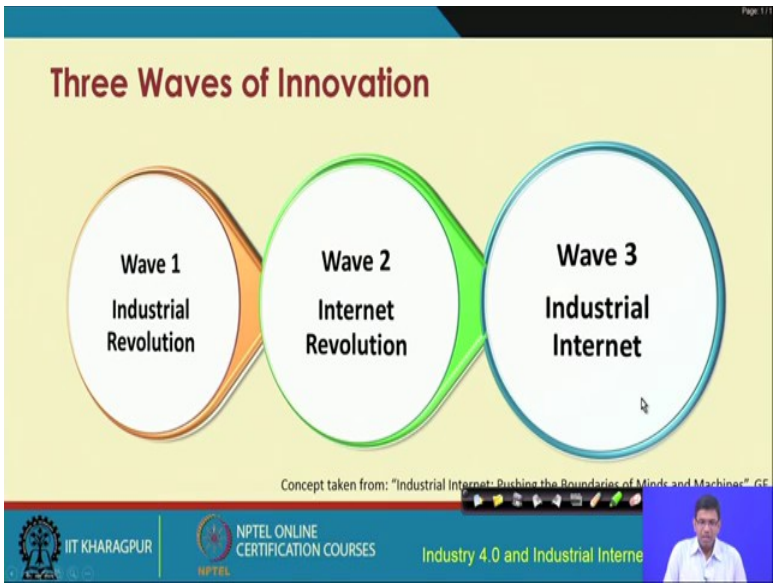
So, General Electric along with few other members founded the industrial internet consortium IIC and this consortium is the body, which is largely the main player for shaping up this industrial internet for the future.

(Refer Slide Time: 01:38)



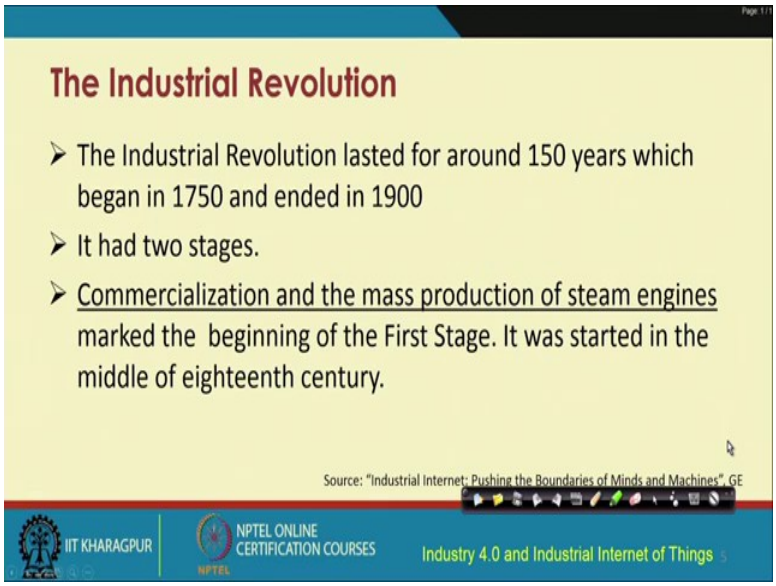
There are three waves of innovation that have gone through in the industrial level. The first wave was the industrial revolution, in the second wave was the internet revolution. And the third wave, in the industries is this industrial internet and this is as per the company general electric, this is how they have visualized the revolution in the industrial sector over the last large number of years that industries have passed through.

(Refer Slide Time: 02:15)



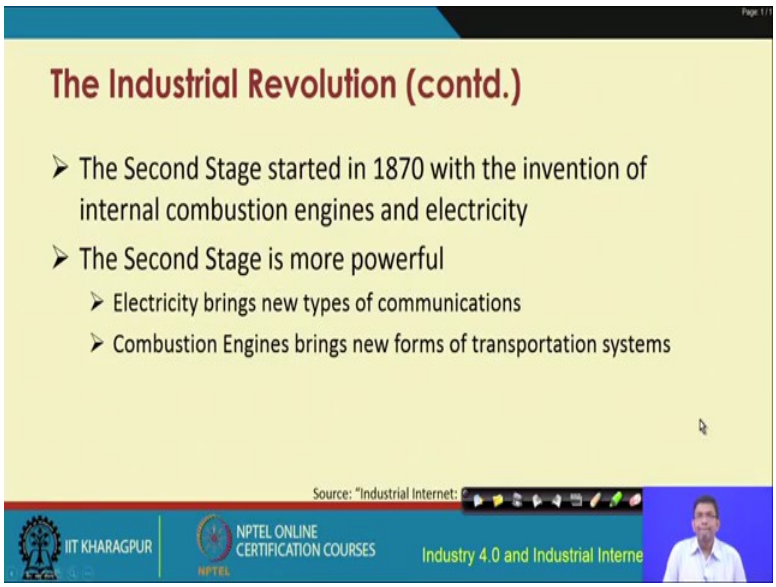
These are basically pictorially shown over here, wave one was the industrial revolution, wave two is the internet revolution, and wave three is the industrial internet.

(Refer Slide Time: 02:28)



So, the industrial revolution happened more than 150 years back, in the 1970s it started, and ended in the early 1900. So, that was the industrial revolution. It had two stages--the first stage was the commercialization and the mass production of steam engines. So, that was the first stage and that started in the middle of the 18th century.

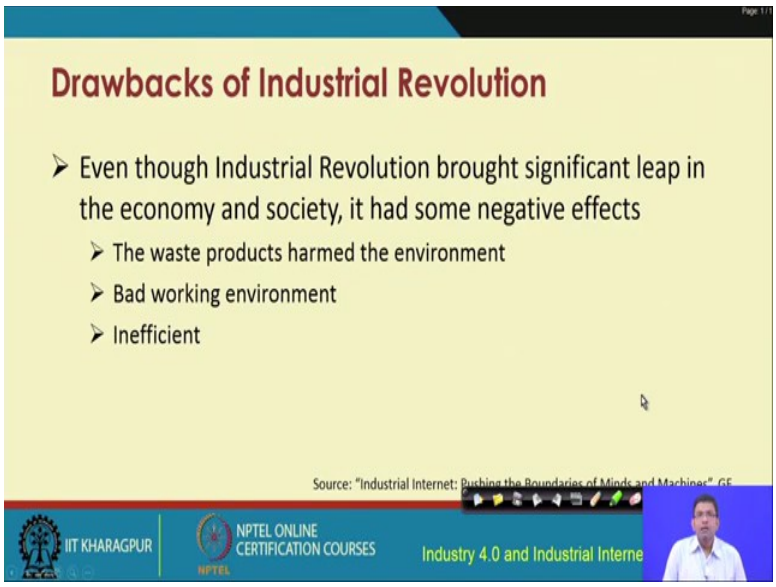
(Refer Slide Time: 02:58)



In the second stage, basically started in 1870, and with the invention of the IC engines, the internal combustion engines and electricity.

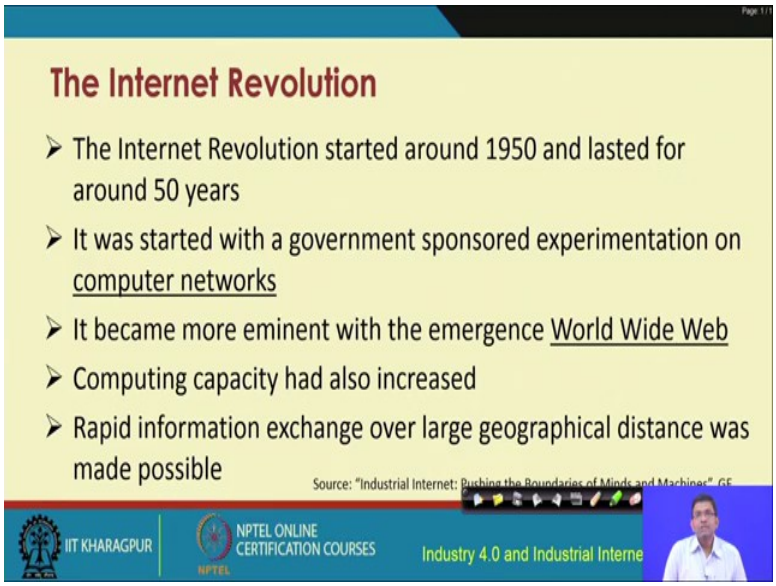
So, the starting of the invention of IC engines, basically led to lot of development in the transportation sector. So, basically all these different engines the petrol engines, the diesel engines, that these different vehicles use are a result of the invention of these IC engines. Electricity also bring brought in lot of different types of advancements; advancements in terms of different types of communications, communication between different people communication, between different machines, and between machine and people. So, all these different things have been possible with the help of the advent of electricity.

(Refer Slide Time: 04:00)



The drawbacks of industrial revolution was that even though industrial revolution was a significant leap in the growth of economy, in the growth of society, and so, on there were different negative aspects. Negative aspects for example, the increase in industrialization, increased the amount of waste products in the society, and these have lot of adverse effects on the environment. Second adverse or, negative effect of industrial revolution was the increase in the bad working environment of the workers. Third is the inefficiency.

(Refer Slide Time: 04:54)



So, these are the different drawbacks of industrial revolution, the industrial revolution was followed by the internet revolution, which started around the nineteen 50s and continued for more than 50 years. So, this internet revolution started with a government sponsored project to build a network of different computers, but in the early days the computers used to be very big in size, these computers were not portable. So, this government sponsored project enabled to prove the concept that from one computer, it is possible to send data to another computer. Now, the question is that how we can use it for increasing the productivity in the industries.

So, basically what we are think I mean what has happened is these different machinery in the industries would be connected to different computers and through this connectivity, what it would be possible is to monitor the condition of these machines in a much more efficient manner than before. So, this computer networks the concept was proven, then came the emergence of the world wide web, and now we can see that the world wide web is something, that is popularly used by everybody in the society and also in the industries particularly all industries have lot of use of internet lot of use of world wide web and so on.

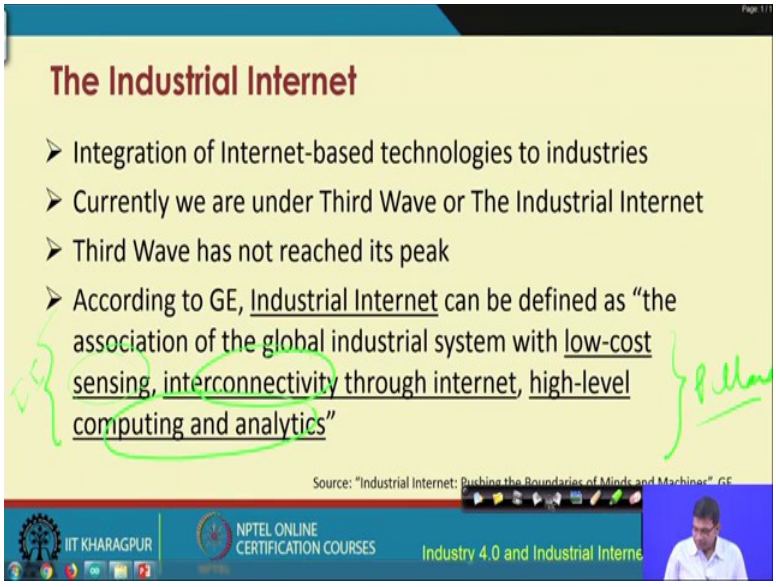
So, computing capacity had also increased over the years, we have small sized computers that have the same power like the computers that were there several decades back. This computing capacity has increased and these computers have also became become

portable. So, because of this portability the internet has also become very popular, everybody now owns a computer, these computers are very high performing than what is to exist several decades back, and also because these are portable now it is possible portable and cheap also these computers are very much cheap.

So, that is why the internet also became very popular and with the emergence of the World Wide Web, different internet-based or web-based applications have been developed for use in the different industrial sectors to improve the efficiency of the different industrial processes.

With the advent of the internet and the computer networks and so on, now it is possible to rapidly in to exchange information rapidly over large geographical distance and that was not possible earlier. So, now, it is possible that different industries would be connected to each other and they may not be geographically co-located. They might be geographically distant apart, but still they would be able to talk to each other.

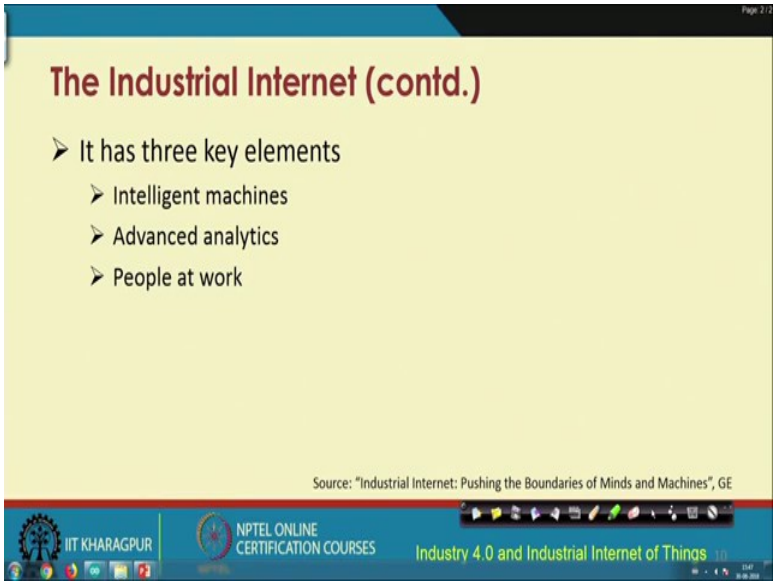
(Refer Slide Time: 08:06)



Then came the industrial internet and this is this new revolution that the world is currently going through, the industrial internet revolution, which is about integration of internet-based technologies to the internet to the industries. So, currently we are under the third wave or the industrial internet wave and it has not yet reached its peak.

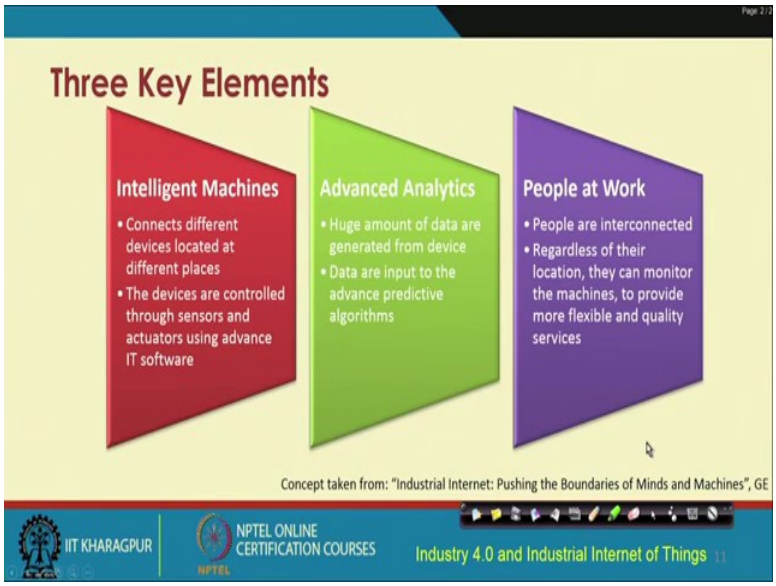
According to GE, industrial internet can be defined as the association of the global industrial system, with low cost sensing, interconnectivity through internet, and high level computing, and analytics. So, as you can see over here we are talking about sensing, interconnectivity, and we are talking about computing and analytics. These are the three different pillars in the development and incorporation of industrial internet.

(Refer Slide Time: 09:21)



So, the industrial internet has three key elements, the first one is that intelligent machines. So, machines have been made much more intelligent, with the introduction of or integration of different computing elements into it. The second key element is advanced analytics, and the third one is we have people at work.

(Refer Slide Time: 09:54)

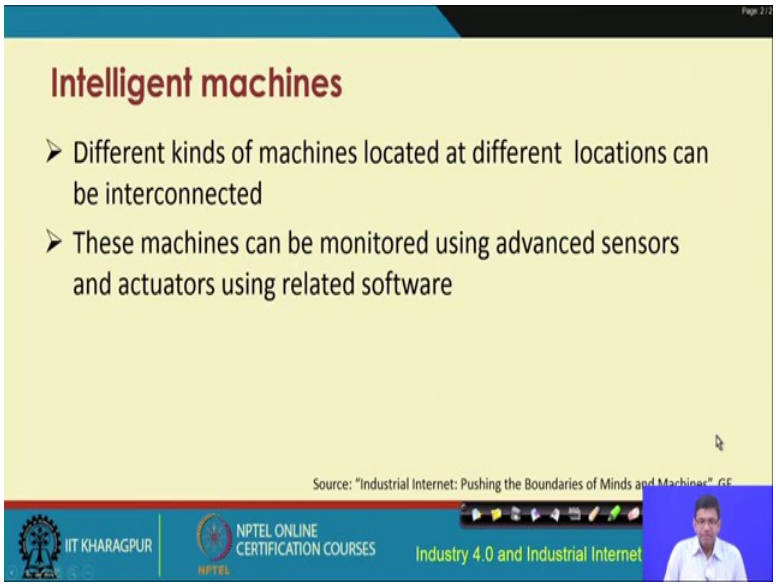


These are the three key elements intelligent machines that help connect different devices and different machines, which may not be co-located the devices are controlled through sensors actuators and using different other advanced IT hardware and software.

Advanced analytics here we are talking about handling huge amount of data, that are generated from these different devices the data are input to the advanced predictive algorithms, that are being proposed and many of these algorithms, have their base, have their origin in advanced statistics in advanced machine learning and artificial intelligence, people at work now it is possible that everybody is connected, interconnected with one another.

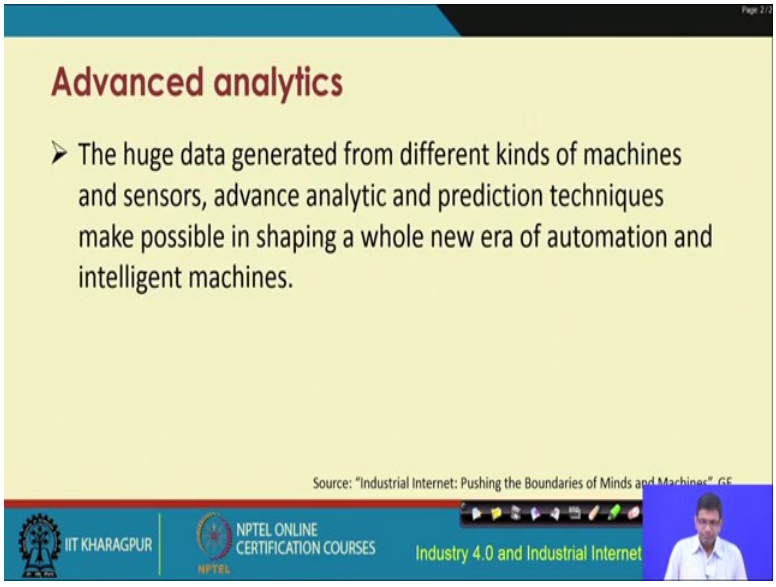
So, regardless of the location of where these different people are now it is possible that these different people, they can monitor the machines, which may not be located, where they are, but might be located distance apart, and it is now possible for people to monitor the condition of the machines to provide more flexibility and quality services to the industries. So, these are the three different key elements.

(Refer Slide Time: 11:12)



Intelligent machines, different kinds of machines, are located at different locations and they are interconnected, these machines can be monitored using advanced sensors and actuators and so, overall everything is connected using different software and hardware elements.

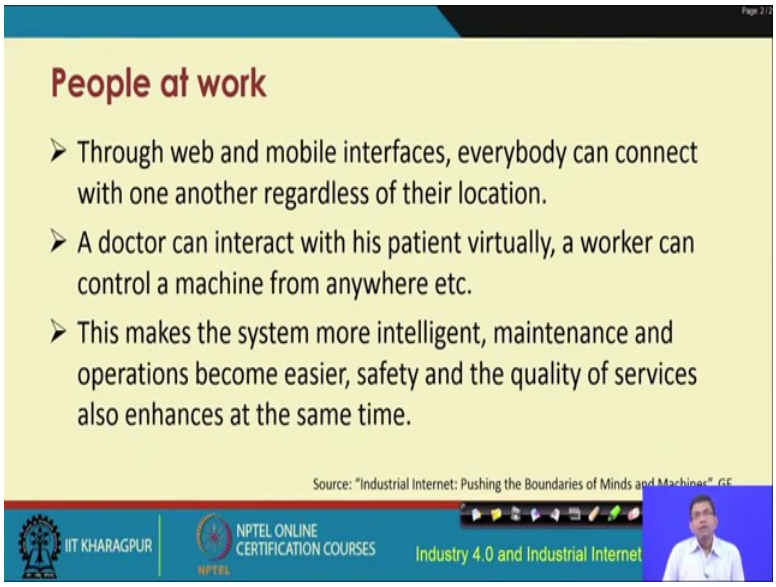
(Refer Slide Time: 11:30)



Advanced analytics, the huge data that are generated from different kinds of machines and sensors, these data can be analyzed with the help of advance statistical machine learning and AI techniques to make different predictions and, within with these

predictions, basically, it is now possible to have intelligent machines being automated and this era of automation and intelligent machines that, we are talking about where advanced analytics can play a huge role.

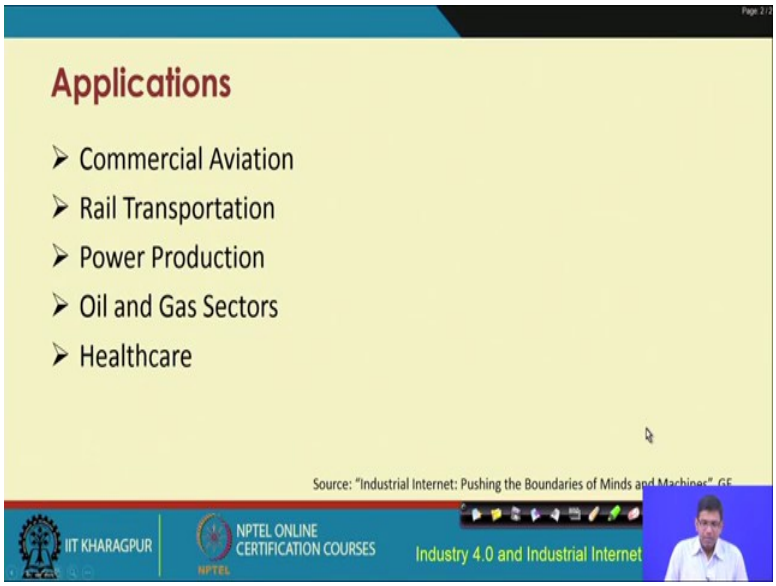
(Refer Slide Time: 12:04)



People at work. So, now it is possible through different collaborative platforms, such as web and mobile interface different people, they would be able to talk to one another they can remain connected to one another and irrespective of where they are located in the world they you can connect to one another.

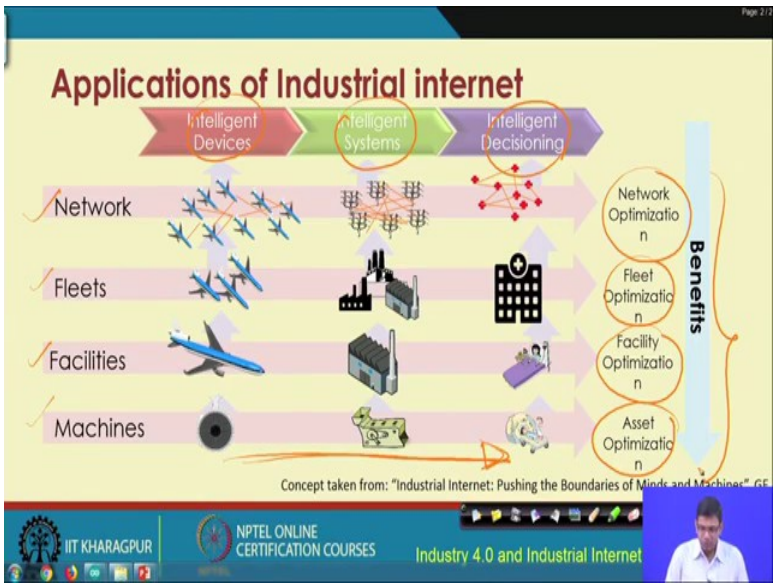
So, basically a doctor can now interact with their patients virtually. A worker can control a machine from anywhere and, this makes the system much more intelligent and with the use of this technology, the industrial internet, it is possible to much more easily maintain and operate the different machines, and also to improve the overall workplace safety and quality of services that are offered by these different industries.

(Refer Slide Time: 12:56)



Different applications of the industrial internet commercial aviation, rail transportation, power production, oil and gas sectors, and healthcare.

(Refer Slide Time: 13:06)

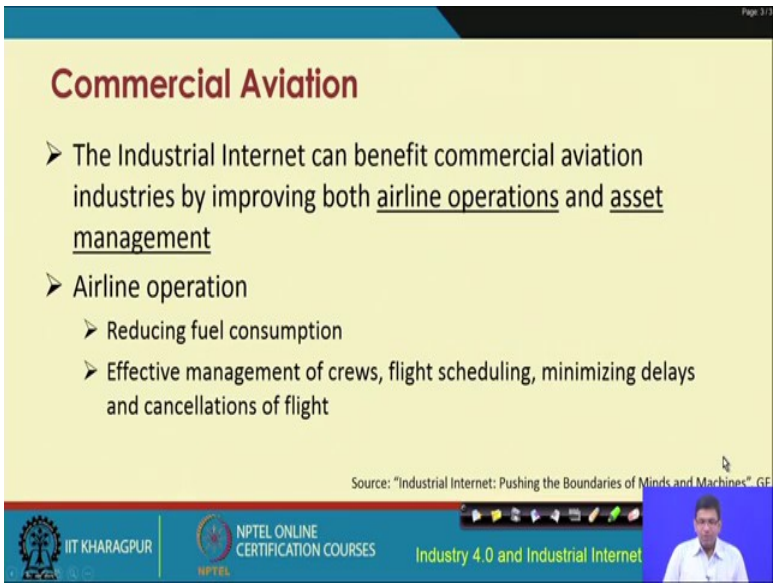


These are some of these different applications of the industrial internet.

We are talking about as you can see over here from machines. So, we are talking about machines, then facilities, fleet and network. So, and gradually as you can see over here we are moving to the world from regular intelligent machines to intelligent systems to ultimately intelligent decision making systems.

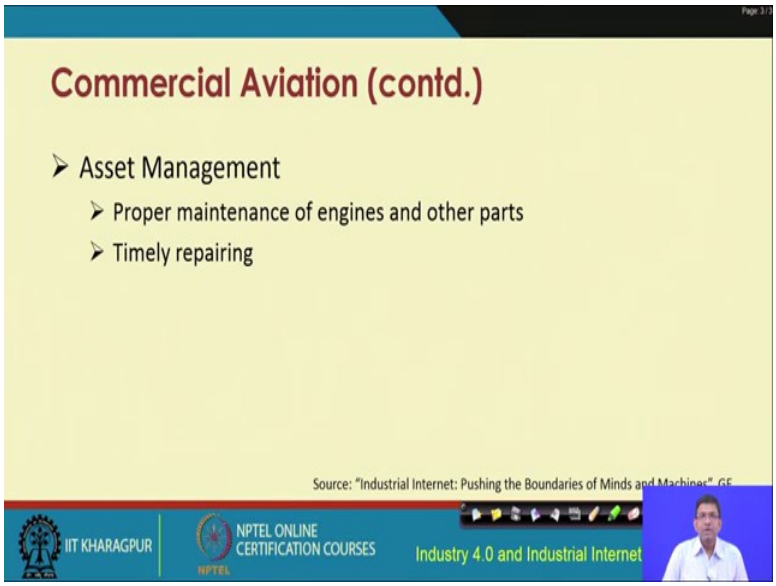
So, this is what and how we are gradually transforming ourselves. So, overall corresponding to this machines facilities fleet and network we are going to optimize at different levels, we are going to have asset optimization, facility optimization, fleet optimization, and network optimization and these are the different benefits of the use of industrial internet overall to improve, the industrial conditions, the industrial processes, the machinery, the monitoring, and the overall working condition, the safety of the different people, who are working in these different industries.

(Refer Slide Time: 14:15)



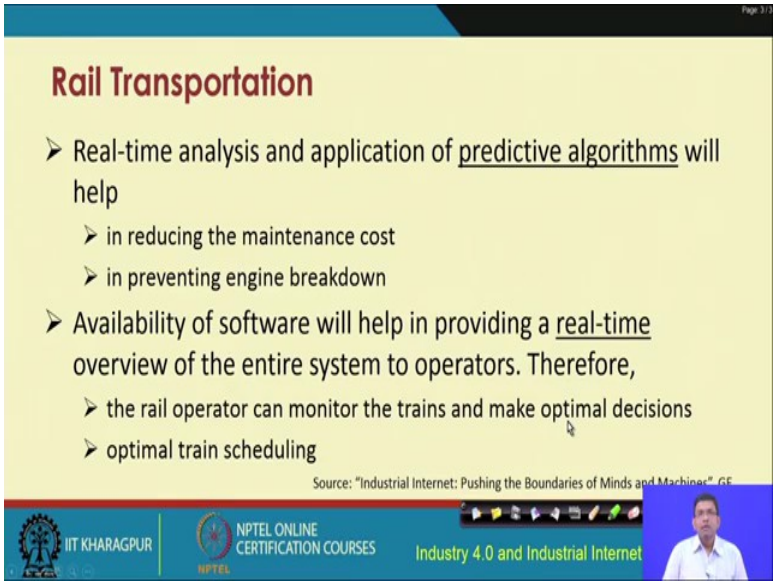
In terms of commercial aviation, the industrial internet, has benefited the commercial aviation industries by improving both airline operations and asset management. Now, in terms of airline operations, with the help of the industrial internet it is now possible, to reduce the overall fuel consumption, to effectively manage the crews, to schedule the flights effectively, minimize delays, and cancellations of different flights.

(Refer Slide Time: 14:48)



In terms of asset management, now it is possible to timely repair the different machines to properly maintain the engines and other parts of the different machinery.

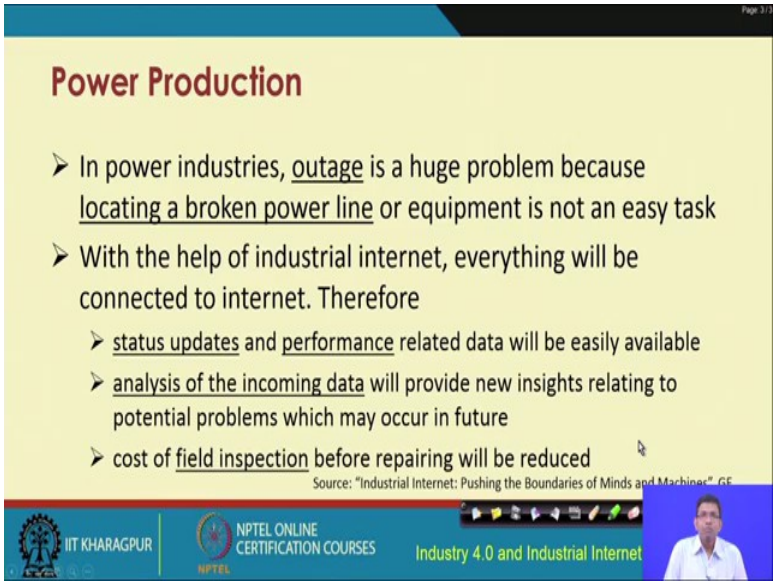
(Refer Slide Time: 14:58)



Rail transportation is now possible with the advent of the industrial internet to have real-time analytics and application of predictive algorithms. And that this will help in reducing the overall maintenance cost, and preventing different breakdown of different machinery parts, such as engines. Availability of software also helps in providing real time overview of the entire system to the operators.

So, with the help of software in a software can be developed to basically monitor the condition of the different machinery in real-time continuously. So, therefore, for example, the rail operator can maintain, and monitor the trains and their conditions, and make optimal decisions, it is also now possible to have optimal train scheduling with the use of different optimization techniques.

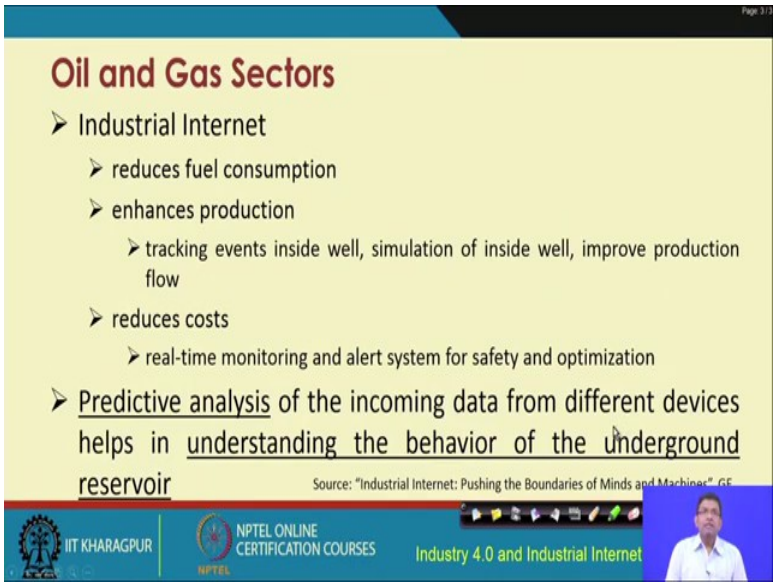
(Refer Slide Time: 15:54)



Power production in the power sector, as well power outage, is a huge problem and because of issue such as somewhere where the power cables are installed, the power line might be broken.

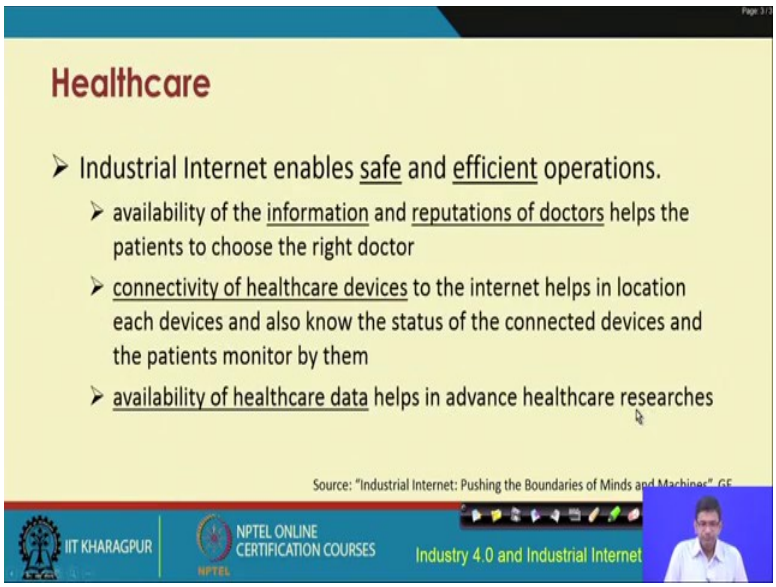
So, it is now important to locate the point where the power line is broken or where the equipment has gone down. So, with the help of the industrial internet, everything will be connected to the internet. And therefore, it is possible to get status updates and performance related data in real-time wherever this data can be made accessible. So, if it is through the internet, then, the data can be accessed from anywhere in the world. Analysis of the incoming data will provide new insights relating to potential problems which can occur in the future cost of field inspection before repairing will also get reduced with their option of the industrial internet.

(Refer Slide Time: 16:57)



In the oil and gas sector the industrial internet can be used to reduce fuel consumption, enhancing productivity and reducing costs. So, different predictive analytics with the help of statistics machine learning artificial intelligence, as I said before can be used to analyze the incoming data from different devices and helping in improving the understanding of the behavior of the underground reservoir.

(Refer Slide Time: 17:25)

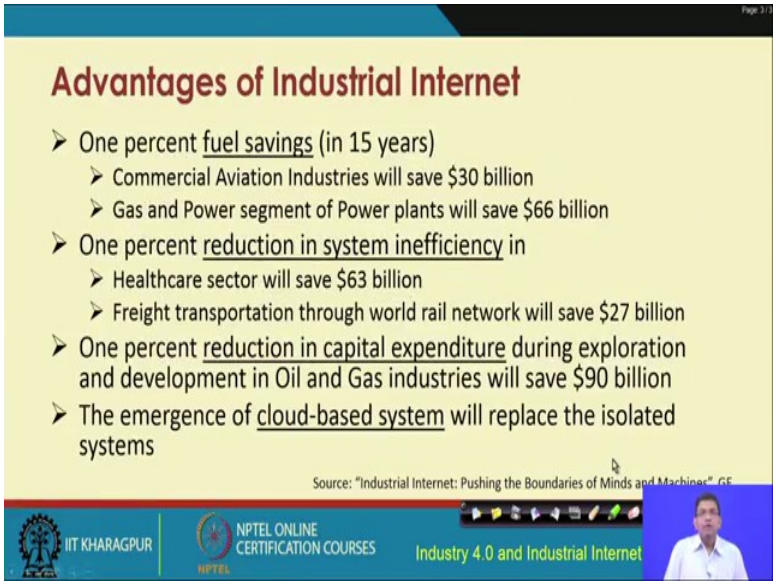


In the healthcare domain industrial internet enables safe and efficient operations, availability of the information, and reputation of different doctors, availabilities of stock

of different medicines, availability of different healthcare machinery, and healthcare diagnostic platforms can help the patients to choose the right doctor, the right facility, the right hospital and in real-time.

So, the industrial internet revolution in the healthcare center is considered to be very crucial, connectivity of healthcare devices is also very important this connectivity basically helps, in what I was telling you earlier to send the data from one point to another. And it is now possible not only to send the data of different patients or whatever from one point to another, but also to help the patients to stay interconnected with one another to share the different information over this collaborative platform and so on. Availability of healthcare data also helps in advancing healthcare research.

(Refer Slide Time: 18:34)

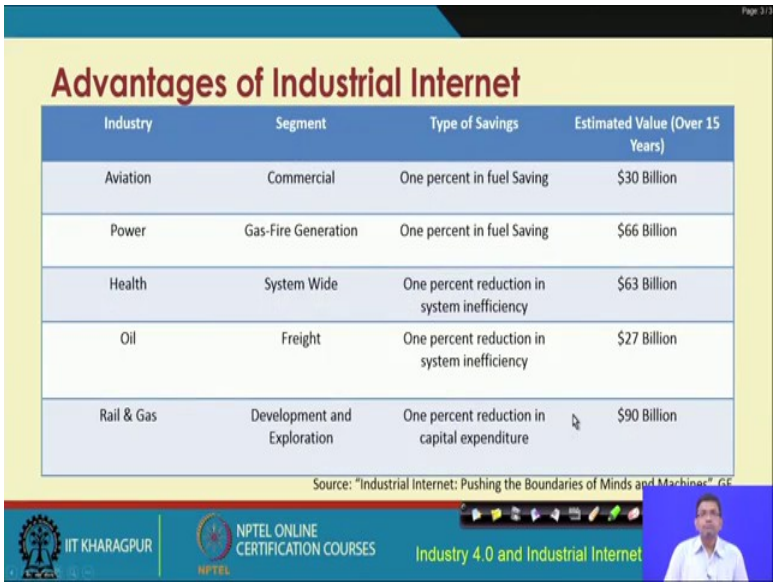


These are the different advantages of the industrial internet, with the adoption of industrial internet, it is now possible to save on fuel in, every 15 years. So, in every 15 years it is expected that the commercial aviation industries through the adoption of industrial internet, we will save over 30 billion dollars.

Gas and power segment of power plants will also save over 65 billion dollars 1 percent reduction in system inefficiency in healthcare center will save 63 billion dollars, freight transportation through world rail network will also save 27 billion dollars, one percent reduction in capital expenditure during exploration and development in oil and gas industries will save 90 billion dollars.

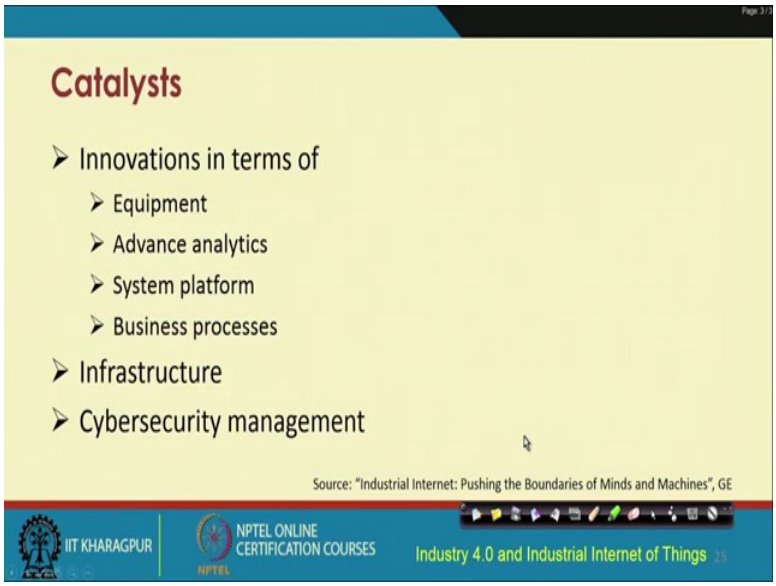
And the emergence of cloud based system will also improve upon what we have been able to achieve. So, far and this figures that we have seen so, far we would be able to improve even further by replacing the isolated systems with the help of cloud-based systems. So, cloud-based systems will help you to get access to the infrastructure that computing infrastructure, the software, hardware, whenever and wherever it is going to be required, in a much easier way, through the pay-per-use concept.

(Refer Slide Time: 20:03)



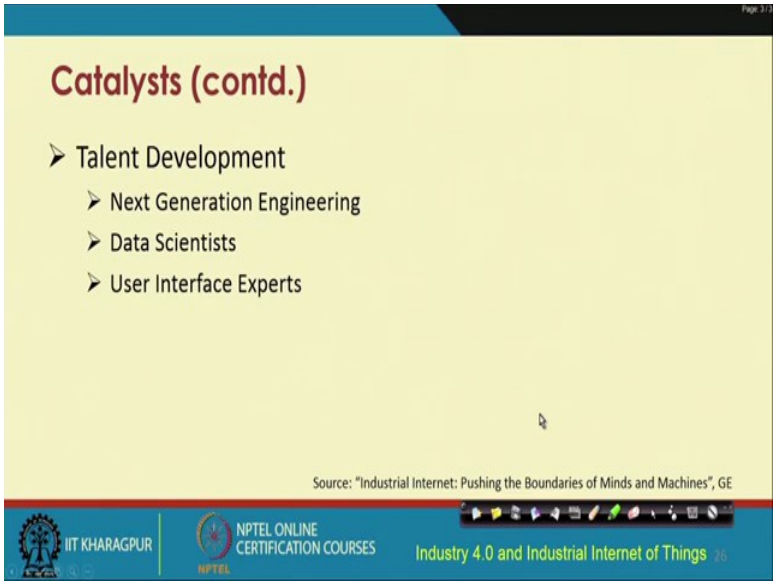
This is a summary of the advantages of the industrial internet, in different industrial domains aviation power health oil and rail and gas.

(Refer Slide Time: 20:13)



These are some of these catalysts which will work to promote the adoption of industrial internet, innovations in terms of equipment advanced analytics safety platform and business processes is number 1. Number 2 is infrastructure and number three is cyber security management and each of these we have already gone through, in much more detail in the previous lectures.

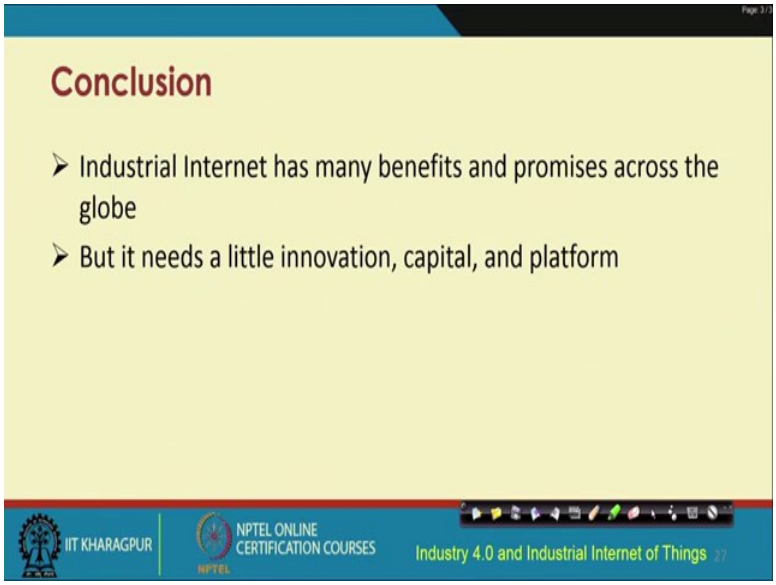
(Refer Slide Time: 20:37)



Talent development here we are talking about the use of different next generation engineering techniques, data scientific techniques, and user interface techniques to

improve upon the talent man manpower, talented manpower, to improve upon their talent.

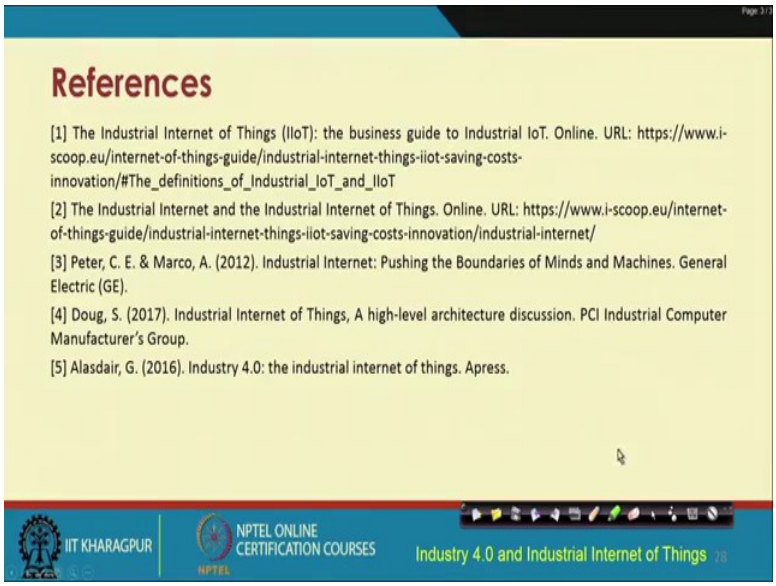
(Refer Slide Time: 21:02)



So, now to conclude industrial internet has many benefits and promises across the globe, it is industrial internet is now globally used it is quite popular, everybody is using it whether it is a small scale industry or a medium scale industry, or a large scale industry. Industrial internet and its different applications are finding different usefulness and one has to leap through this usefulness to improve upon the efficiency of the workplace of the processes of the machines in the industries even further.

But what is important also to have further innovation cutting down on the costs, further, through these innovative steps and adoption of different platforms and industrial internet platforms, through the adoption of all of these it is now possible to improve the overall efficiency and cutting down on the perform on, the reduced performance issues through the adoption of industrial internet.

(Refer Slide Time: 22:00)



These are some of these references, and with this we come to an end, of this particular lecture on industrial internet, as we have seen in this particular lecture, industrial internet has lot of similarity with the industrial IoT, which again has also a lot of similarity with automation issues in the industry, but all of these even though are similar, they have their own distinct identity. The origin is also distinct and that is how these have also become very popular on their own standing.

Thank you.