

Introduction to Internet of Things
Prof. Sudip Misra
Department of Computer Science & Engineering
Indian Institute of Technology, Kharagpur

Lecture – 54
Industrial Internet of Things – Part – II

So, let us now continue our discussion of industrial IoT. So, earlier we understood the basics of IIoT, how IIoT differs in principle from regular IoT what is the difference between IoT and M-2-M and having understood all of these different basic concepts we are now about to understand that what are the specific applications of IIoT in the industrial sector.

(Refer Slide Time: 00:54)

Applications of IIoT

- ✓ The key application areas of IIoT are -
- ✓ Manufacturing industry
- ✓ Healthcare Service industry
- ✓ Transportation & logistics
- ✓ Mining
- ✓ Firefighting

IIT KHARAGPUR | **NPTEL ONLINE CERTIFICATION COURSES** | **Introduction to Internet of Things**

So, some of the key application areas of IIoT are manufacturing industry, health care industry, transportation and logistics mining and firefighting.

(Refer Slide Time: 01:06)

Manufacturing Industry

- ✓ The devices, equipment, workforce, supply chain, work platform are integrated and connected to achieve smart production. This will lead to –
 - ✓ reduction in operational costs
 - ✓ improvement in the productivity of the worker
 - ✓ reduction in the injuries at the workplace
 - ✓ resource optimization and waste reduction
 - ✓ end-to-end automation.

IIT Kharagpur | **NPTEL ONLINE CERTIFICATION COURSES** | **NPTEL** | **Introduction to Internet of Things**

In terms of manufacturing in a manufacturing industry there are lots of manufacturing devices there are equipments work force supply chain work platform different work platforms are there. So, these have to be integrated and connected to achieve smart production. So, they have to be internetworked. So, we have different manufacturing machines manufacturing devices equipments work force then the entire supply chain manufacturing supply chain from production to the end users the entire supply chain and then the work platform. So, all of these have to be integrated and connected to improve the production overall industrial production.

So, these have to be done in order to reduce the operational costs improve the productivity of the worker reduce injuries at the workplace this is very important actually safety applications of IIoT are very important these are very interesting and these are very popular safety applications. So why we want to use IIoT is one of the important applications is to improve the safety in the manufacturing plant in the industrial different other types of plants. Resource optimization and waste reduction is also very important industrial you know this is a very important problem resource optimization is a very important problem in a industrial engineering. So, this has to be taken care of waste reduction as well and end to end automation. So, this is very important in it is a very important requirement in the manufacturing industry and it has to be taken care of.

(Refer Slide Time: 03:17)

Healthcare Service Industry

- ✓ Patients can be continuously monitored due to the implanted on-body sensors. This has led to –
 - ✓ improved treatment outcome
 - ✓ costs has reduced
 - ✓ improved disease detection
 - ✓ improved accuracy in the collection of data
 - ✓ improved drugs management.

IIT Kharagpur | **NPTEL ONLINE CERTIFICATION COURSES** | **NPTEL** | **Introduction to Internet of Things**



In the second application of IIoT is in the health care sector. So, you know using IIoT solutions patients can be continuously monitored due to the implanted on body sensors which can improve the treatment outcome overall costs of treatment can be reduced, improved disease detection can be done and improved accuracy from the data; that is that are collected can be achieved an overall the drugs drugs that are administered on the patients and the overall inventory. The control of the drugs, the procurement control storage and so on of the drugs they can be improved.

(Refer Slide Time: 04:08)

Transportation & logistics

- ✓ To improve safety, efficiency of transportation, Intelligent Transportation system (ITS) is developed which consists of connected vehicles. ITS provides –
 - ✓ Vehicle – to – sensor connectivity
 - ✓ Vehicle – to – vehicle connectivity
 - ✓ Vehicle – to – internet connectivity
 - ✓ Vehicle – to – road infrastructure
- ✓ Dedicated short-range communications (DSRC) is the key enabling technology for V2V and V2R communications.

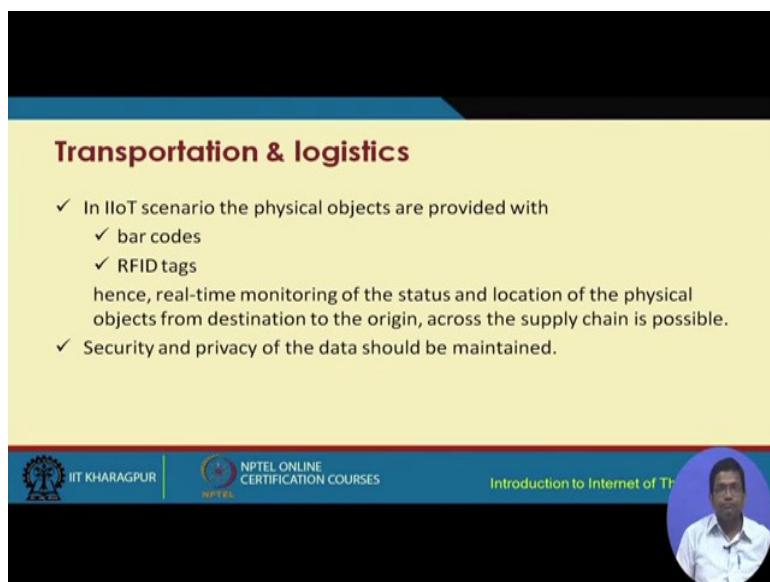
IIT Kharagpur | **NPTEL ONLINE CERTIFICATION COURSES** | **NPTEL** | **Introduction to Internet of Things**



So, IIoT solutions are very attractive in the health care sector in the transportation and logistics sector as well in order to improve transportation safety, efficiency of transportation, intelligent transportation systems can be developed which consists of connected vehicles. So, one of the key building blocks for transportation IIoT applied to transportation is the concept of intelligent transportation system or connected vehicles. So, intelligent transportation systems come in different forms we have the concepts of in its we have the concepts of vehicle to sensor connectivity, vehicle to vehicle connectivity, vehicle to internet connectivity and vehicle to road infrastructure connectivity.

So, there are different types of connectivity's that are required in its there is short range communication in the form of DSRC that enables the realization of vehicle to vehicle and vehicle to road infrastructure communication V2V, V2R sometimes it is also known as V2I, V2 Vehicle to infrastructure communication.

(Refer Slide Time: 05:37)



Transportation & logistics

- ✓ In IIoT scenario the physical objects are provided with
 - ✓ bar codes
 - ✓ RFID tagshence, real-time monitoring of the status and location of the physical objects from destination to the origin, across the supply chain is possible.
- ✓ Security and privacy of the data should be maintained.

NPTEL ONLINE CERTIFICATION COURSES

Introduction to Internet of Things

So, DSRC is very important key enabling technology for achieving the objective of vehicle to vehicle and vehicle to roadside infrastructure communication. In IIoT scenario the physical objects are provided with bar codes RFID tags. So, that real time monitoring of the status and location of the physical objects may be the trucks where they are what you know what is the condition of the different goods that are carried in the trucks all of these things can be monitored in real time from the origin irrespective of where the trucks are entire supply chain

can be monitored with IIoT solutions entire supply chain the status of the good that status of the vehicle you know everything can be monitored.

(Refer Slide Time: 06:30)

Mining

- ✓ To prevent accidents inside the mines - RFID, Wi-Fi and other wireless technologies are used, which
 - ✓ provides early warning of any disaster
 - ✓ monitors air-quality
 - ✓ detects the presence of poisonous gases inside the mines
 - ✓ oxygen level inside the mines.

IT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Introduction to Internet of Things



Security and privacy of the data should also be maintained and that is quite obvious I do not need to elaborate further on this particular aspect. In the mining industry very important industrial IIo, sorry industrial IoT solutions are very important in the mining industry it is very common to have different types of accidents in the mines. So, RFID based solutions are Wi-Fi and different other sensors and other wireless technologies Zigbee, Bluetooth, etcetera can be deployed to collect data to provide early warning before any disaster actually strikes can be used in the mines to improve to monitor not improve, but monitor the air quality what is the air quality

And this is the very important problem in the mining sector you know monitoring the air quality inside the mine detecting the presence of different types of poisonous gases SOx gases NOx gases and you know different other poisonous gases like carbon mono oxide and so on inside the mine which is a very common problem. How much is the oxygen level inside the mine? So, all of these things can be monitored inside the mines using IIoT solutions.

(Refer Slide Time: 07:47)

Firefighting

- ✓ Sensor networks, RFID tags are used to perform
 - ✓ automatic diagnosis
 - ✓ early warning of disaster
 - ✓ emergency rescue
 - ✓ provides real-time monitoring

Hence, improves public security.

NPTEL ONLINE CERTIFICATION COURSES

Introduction to Internet of Things



Firefighting is another application where RFID tags can be fitted to these different devices for firefighting for automatic diagnosis, early warning, and emergency rescue. In the fire infrastructure that are deployed typically in the buildings, different RFID tags and different sensors can be fitted to these. You know fire detection devices, emergency rescue, and providing real-time monitoring. So, all these will improve the overall security and safety of public infrastructure.

(Refer Slide Time: 08:37)

Examples of IIoT

- ✓ Examples of IIoT are -
 - ✓ unmanned aerial vehicles (UAVs) to inspect oil pipelines.
 - ✓ monitoring food safety using sensors.
 - ✓ minimizing workers' exposure to noise, chemicals and other hazardous gases.
 - ✓ unmanned marine vehicle which can collect data up to a year without fuel or crew.

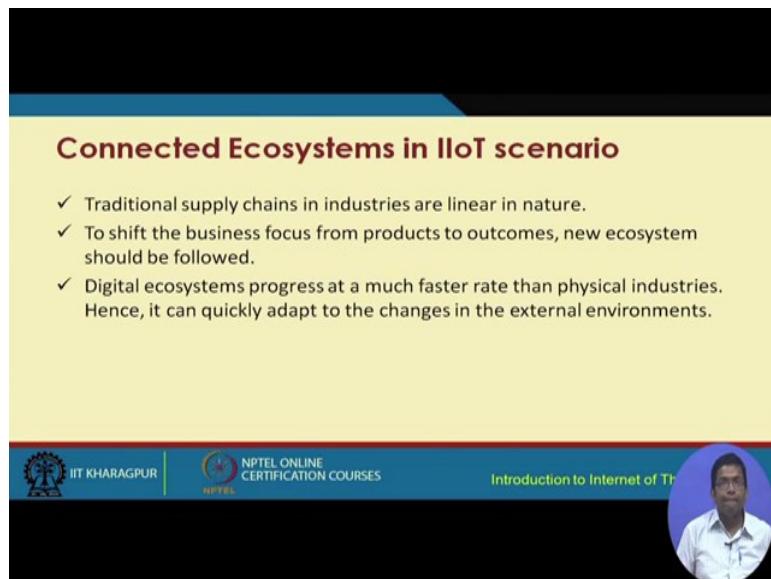
NPTEL ONLINE CERTIFICATION COURSES

Introduction to Internet of Things



So, some of the examples of IIoT include use of unmanned aerial vehicles or the drowns to inspect oil pipelines monitoring food safety using sensors minimizing workers exposure to noise chemicals hazardous materials and so on unmanned marine vehicles can be deployed to collect data you know annually or throughout the year throughout the months and so on without any fuel or crew.

(Refer Slide Time: 09:12)



Connected Ecosystems in IIoT scenario

- ✓ Traditional supply chains in industries are linear in nature.
- ✓ To shift the business focus from products to outcomes, new ecosystem should be followed.
- ✓ Digital ecosystems progress at a much faster rate than physical industries. Hence, it can quickly adapt to the changes in the external environments.

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Introduction to Internet of Things

So, what we have are connected ecosystems in the IIoT domain. So, what we have is we have traditional supply chains and these traditional supply chains in these industries are linear typically linear in nature. So, it is required to shift the business focus from products to outcomes and for that these digital ecosystems can come IIoT based digital ecosystems can come to rescue. So, digital ecosystems progress at much faster rate than the physical industries. Hence it can quickly adopt sorry adapt to the changes in the external environments.

(Refer Slide Time: 09:57)

Integration of Digital and Human Workforce

- ✓ In IIoT, machines become more intelligent. Hence, the automated tasks can be done in the industries at lower costs and higher quality level.
- ✓ Humans will work with machines, the outcome will be higher overall productivity.
- ✓ IIoT will reform and redefine the skills of the workers.

IIT Kharagpur | NPTEL ONLINE CERTIFICATION COURSES | Introduction to Internet of Things



So, it is required to integrate digital technologies with the human work force. So, you know IIoT cannot be exclusively M-2-M this we have to remember we have to have humans in the loop. So, humans will work with machines and the overall outcome will be improved productivity of the system.

(Refer Slide Time: 10:26)

Creation of New Jobs

- ✓ The creation of new composite industries, such as precision agriculture, digital healthcare system, digital mines etc., will lead to development of new job opportunities.
- ✓ Highly automated machines will require lesser number of unskilled workers, but will require skilled experts with digital and analytical skills.

IIT Kharagpur | NPTEL ONLINE CERTIFICATION COURSES | Introduction to Internet of Things



So, IIoT will reform and redefine the skills of the workers. New jobs can be created with the help of IIoT it is not that you know typically people think that automation or IIoT based

solutions will cut down on the number of jobs, but that is not true. So, jobs new jobs get created because you know new technologies get introduced.

Things like a you know new composite industries precision agriculture digital health care digital mines these require you know skilled man power and these skilled man power is what is required and you know this automation through IIoT is in turn going to create new jobs with requiring new skill sets and you know. So, this basically you know IIoT will not cut down on the required number of jobs in the industries.

(Refer Slide Time: 11:29)

Reformation of Robots

- ✓ In IIoT environment, robots are featured with three capabilities : sensing, thinking and acting. They will be reformed with the ability to carry out repetitive tasks.
- ✓ Robots will be more intelligent but will work under the supervision of human beings. Their availability will increase.
- ✓ Robots will be reprogrammable to perform new tasks. They have the capability to 'learn' faster.

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Introduction to Internet of Things

Robots robots have traditionally been used in the industry and in IIoT robots are a very important component you know in a new form in a new way robots can be used and these robots can sense they can think they can act they can perform different tasks. So, they will be formed with the ability to carry out repetitive tasks robots will be more intelligent they are more intelligent and they walk under the supervision of, they can also work under the supervision of human beings their availability increases and they can be programmed reprogrammed and so on and so forth to perform new tasks and that way they can learn faster.

So, robots in a reformed manner can be used in the IIoT to perform the industrial processes in a much more efficient manner in much more faster way decisions can be made and so on; over all improving the industrial processes industrial you know efficiency industrial safety and so on.

(Refer Slide Time: 12:42)

Challenges in IIoT

- ✓ Primary challenges
 - Identification of objects or things
 - Manage huge amount of data
 - Integrate existing infrastructures into new IIoT infrastructure
 - Enabling data storage

IIT Kharagpur | **NPTEL ONLINE CERTIFICATION COURSES** | **NPTEL** | **Introduction to Internet of Things**

So, some of the challenges of IIoT, building IIoT are listed over here identification of objects or things is important and we already looked at the identification of these things you know how do you associates identifiers to these things we have already looked into these in the context of regular IoT and the same applies here as well.

Managing huge amount of data is another challenge to be worked on in order to address the problems of IIoT in order to deploy IIoT solutions integrating existing infrastructure into new IIoT infrastructure and enabling data storage these are some of the challenges behind IIoT. There are safety challenges as I told you before safety is very important. It is a fundamental problem in the industry in the industrial sector safety is crucial.

(Refer Slide Time: 13:31)

The slide has a yellow header with the title 'Challenges in IIoT (contd.)' and a sub-section '✓ Safety Challenges'. Below this, there is a list of four challenges, each with a small circular icon to its left:

- Worker health and safety (red bar)
- Regulatory compliance (green bar)
- Environmental protection (purple bar)
- Optimized operations (blue bar)

At the bottom of the slide, there are logos for IIT Kharagpur, NPTEL, and a circular profile picture of a man. The text 'Introduction to Internet of Things' is also visible.

So, whether we are talking about the health care industry because you know in the health care industry as well in the hospitals and health care workers they are exposed to lot of problems they are exposed to lot of challenges and which can harm their health and so on.

The same thing for if we are talking about mining industry if we are talking about the transportation industry if we are talking about the steel industry and different other industries there are lot of safety challenges that are there and so, workers health and safety are of primary concern in this industry. So, worker health and safety regulatory complains there are different regulatory bodies in a requiring you know complains of the machines the people their processors in the industry and so on. So, these and regulatory compliance with respect to safety particularly is very crucial.

Environmental protection is very important you know industries and environment they often do not go hand in hand. So, lot of challenges exist and lot of challenges are posed by the industries on the environment in which they work then optimized operations. So, these are some of these challenges particularly concerning safety in industrial safety that have to be taken care of through IIoT solutions.

(Refer Slide Time: 15:21)

Challenges in IIoT (contd.)

- ✓ Hazards (related)
 - Handling, storing or using hazardous substances
 - Oxygen deficiency
 - Particulates
 - Radiation
 - Physiological stress

 IIT Kharagpur |  NPTEL ONLINE CERTIFICATION COURSES |  Introduction to Internet of Things

There are different hazards as well handling of different hazardous substances storing of the hazardous substances and so on oxygen deficiency particulate matters. So, particulate matters like you know fly ash and so on then radiation different types of radiation electromagnetic radiation and so on and physiological stress all these are different types of hazards.

(Refer Slide Time: 15:55)

Challenges in IIoT (contd.)

Standardization

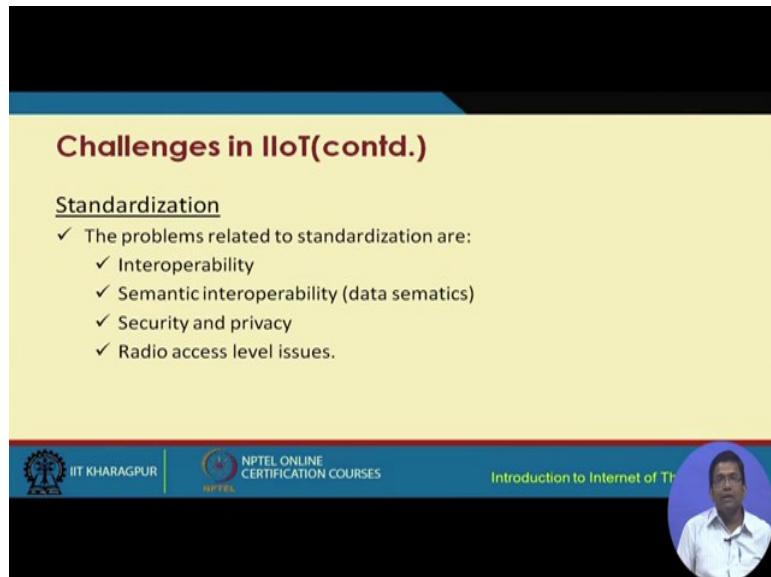
- ✓ Standardization plays an important role in the development of the system.
- ✓ Goal: To improve the interoperability of the different systems/ applications and allow the products/services to perform better.

 IIT Kharagpur |  NPTEL ONLINE CERTIFICATION COURSES |  Introduction to Internet of Things

That have to be taken into consideration for offering challenges through the use of IIoT. Standardization is very important in the development of any system. So, in the context of

IIoT what is required is to improve the interoperability of the different systems applications and allowing the products and services to perform better.

(Refer Slide Time: 16:12)



Challenges in IIoT(contd.)

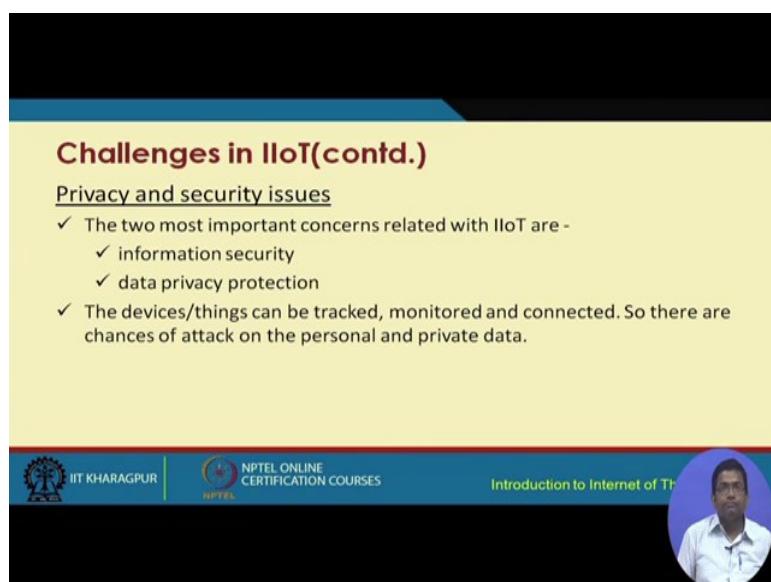
Standardization

- ✓ The problems related to standardization are:
 - ✓ Interoperability
 - ✓ Semantic interoperability (data semantics)
 - ✓ Security and privacy
 - ✓ Radio access level issues.

IIT Kharagpur **NPTEL ONLINE CERTIFICATION COURSES** **NPTEL** **Introduction to Internet of Things** 

In terms of standardization the problems related to standardization include interoperability semantic interoperability. So, there is a difference. So, in semantic interoperability basically one is focusing on data semantics. So, the meaning; so, the you know interoperability in terms of semantics is what semantic interoperability specifically takes care security and privacy and radio access level issues.

(Refer Slide Time: 16:42)



Challenges in IIoT(contd.)

Privacy and security issues

- ✓ The two most important concerns related with IIoT are -
 - ✓ information security
 - ✓ data privacy protection
- ✓ The devices/things can be tracked, monitored and connected. So there are chances of attack on the personal and private data.

IIT Kharagpur **NPTEL ONLINE CERTIFICATION COURSES** **NPTEL** **Introduction to Internet of Things** 

There are different privacy and security issues as well the two most important concerns needed with IIoT are information security and data privacy protection the devices and the things can be tracked monitored and connected. So, they there are chances of attack as it happens in any other type of network as well this IIoT is also a network; it is a huge network where different machines crucial machines there are different systems humans everybody is connected.

So, these are prone to different attacks there could be different vulnerabilities in these networks. So, consequently, you know. So, these has to be taken care of the security issues have to be taken care of privacy is very crucial because from the industry there are different data the sensors are collecting.

(Refer Slide Time: 17:44)

Challenges in IIoT(contd.)

Privacy and security issues

✓ Examples –

- ✓ Healthcare industry – the medical data of a patient must not be tampered, or altered by any person in the middle.
- ✓ Food industry – the deterioration of any food item being sent to the company must be kept confidential as it will affect the reputation of the company.

 IIT Kharagpur |  NPTEL ONLINE CERTIFICATION COURSES |  Introduction to Internet of Things

So, the privacy of these data have to be take care of. So, information security data privacy protection all these are very crucial issues in the context of IIoT building of IIoT.

So, for example, in the health care industry the medical data of the patient must not be tampered or altered by any person in the middle in the food industry the deterioration of any food item that is being sent to the company should be kept confidential as it will affect the reputation of the company.

(Refer Slide Time: 18:13)



Risks associated with IIoT in Manufacturing

- ✓ Though IIoT provides new opportunities, but few factors may cause hindrance in the path to success, which are :
 - ✓ lack of vision and leadership
 - ✓ lack of understanding of values among management employees
 - ✓ costly sensors
 - ✓ inadequate infrastructure.

IIT Kharagpur | **NPTEL ONLINE CERTIFICATION COURSES** | **NPTEL** | **Introduction to Internet of Things**



So, these are very important you know privacy challenges or security challenges posing the building of IIoT solutions. Through IIoT a sorry though IIoT provides new opportunities, but few factors may cause the hindrance in the path to success these include the lack of vision and leadership lack of understanding of values among the management employees costly sensors and in adequate infrastructure. So, these are some of the risks that are faced by people who want to the management who want to deploy IIoT in the industry.

(Refer Slide Time: 18:47)



Meet the challenges: Sensor improvement

- ✓ Improvement in sensor technologies –
 - ✓ miniaturization
 - ✓ performance
 - ✓ cost and energy consumption.

IIT Kharagpur | **NPTEL ONLINE CERTIFICATION COURSES** | **NPTEL** | **Introduction to Internet of Things**



So, other challenges include improvement at the sensors miniaturization of the sensors is very crucial you know we are talking about you know day by day we are talking about very small scale small sized sensors that can perform as good as if not better than these existing big sized sensors. So, miniaturization of the sensors is very important nowadays, we are talking about name spaced sensors which make the sensor the shape of the size of the sensor very small and these sensors can perform very well as well even if they are small in size. They can perform very well and the overall by through the miniaturization process the overall cost and energy consumption the overall cost can be brought down and the energy consumption can also be addressed can also be improved because small sized sensor is lightly to consume less energy compared to bigger sized sensors.

(Refer Slide Time: 19:42)

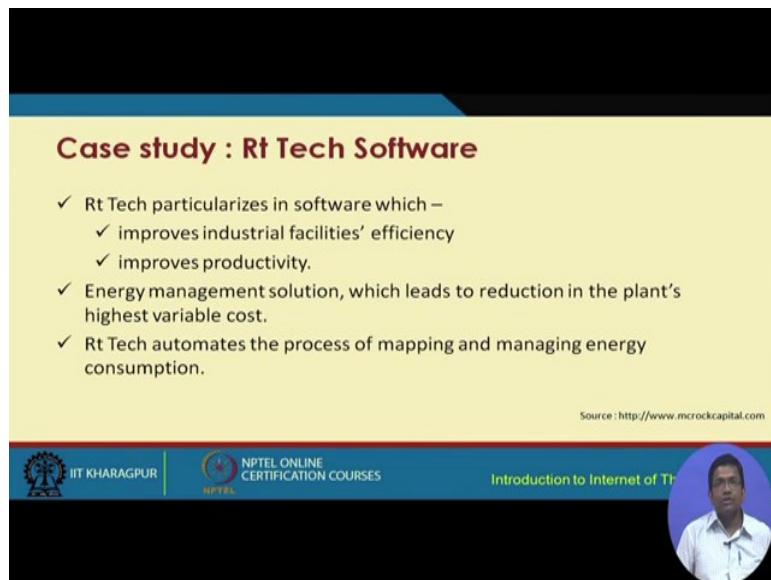
Meet the challenges : Manufacturing

- ✓ Manufacturers use software capabilities to improve operational efficiency through–
 - ✓ predictive maintenance
 - ✓ savings on scheduled repairs
 - ✓ reduced maintenance costs
 - ✓ reduced number of breakdowns.

IIT Kharagpur | NPTEL ONLINE CERTIFICATION COURSES | Introduction to Internet of Things

So, the other challenges with respect to manufacturing. So, you know when we are talking about manufacturing typically these are software based computer based and these are used to improve the overall operational efficiency. So, predictive maintenance savings on scheduled repairs reduced maintenance cost maintenance costs and reduced number of breakdowns are important challenges and important issues that have to be taken into consideration while trying to introduce IIoT in the manufacturing industry.

(Refer Slide Time: 20:19)



Case study : Rt Tech Software

- ✓ Rt Tech particularizes in software which –
 - ✓ improves industrial facilities' efficiency
 - ✓ improves productivity.
- ✓ Energy management solution, which leads to reduction in the plant's highest variable cost.
- ✓ Rt Tech automates the process of mapping and managing energy consumption.

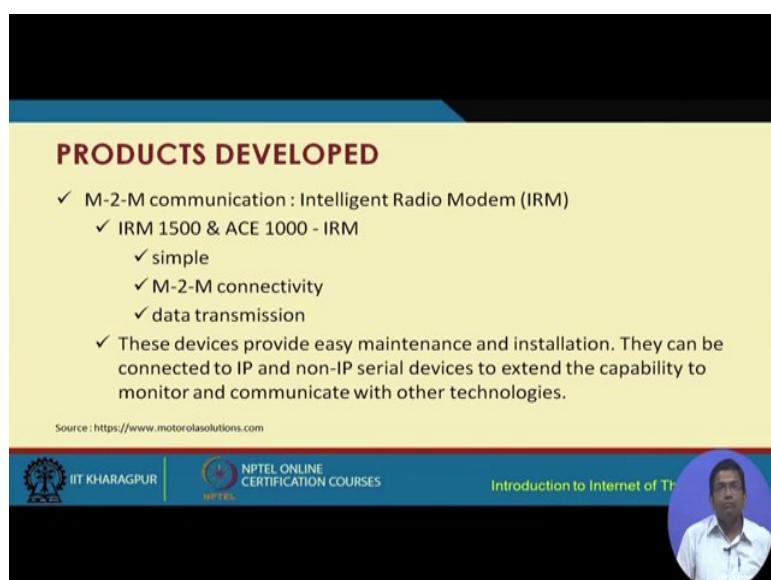
Source : <http://www.microckcapital.com>

 IIT KHARAGPUR |  NPTEL ONLINE CERTIFICATION COURSES

Introduction to Internet of Th 

So, there was an industry the Rt tech software. So, this basically particularizes in software which improves the industrial facilities efficiency and improves the overall industrial productivity. So, energy management solution which leads to reduction in the plants highest variable cost was a produced was designed and this particular company automates the processes of mapping and managing energy consumption.

(Refer Slide Time: 20:52)



PRODUCTS DEVELOPED

- ✓ M-2-M communication : Intelligent Radio Modem (IRM)
 - ✓ IRM 1500 & ACE 1000 - IRM
 - ✓ simple
 - ✓ M-2-M connectivity
 - ✓ data transmission
 - ✓ These devices provide easy maintenance and installation. They can be connected to IP and non-IP serial devices to extend the capability to monitor and communicate with other technologies.

Source : <https://www.motorolasolutions.com>

 IIT KHARAGPUR |  NPTEL ONLINE CERTIFICATION COURSES

Introduction to Internet of Th 

The products that they develop include M-2-M based communication based systems and intelligent radio modems and these are the some of these products and their specifications

given over here these devices provide easy maintenance and installation they can be connected to IP or non IP devices to extend the capability to monitor and communicate with other technologies.

(Refer Slide Time: 21:16)

PRODUCTS DEVELOPED (contd.)

- ✓ Comtrol – IO Link Master Gateway
 - ✓ It can be easily integrated into the industrial network with existing and new installations.
 - ✓ It supports Ethernet/IP, PROFINET (PNIO) and Modbus TCP.

Source:
<http://iollserv.maximintegrated.com>
<http://www.comtrol.com>

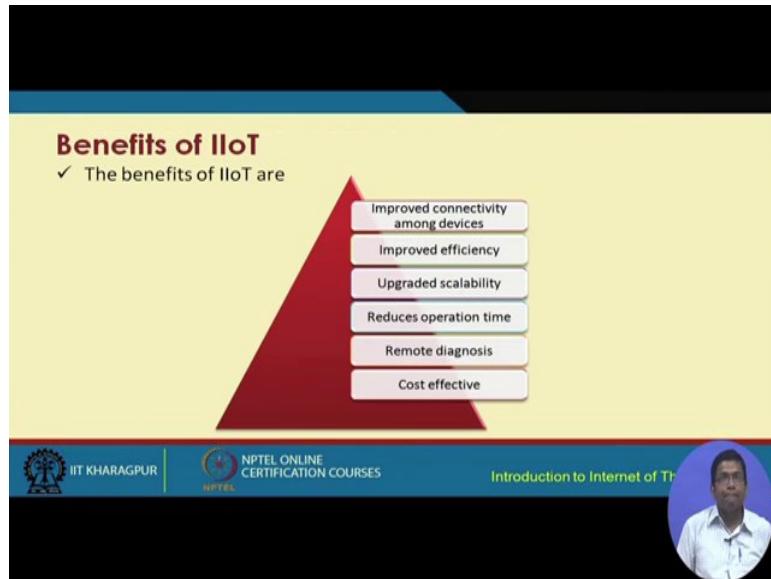
IIT KHARAGPUR | **NPTEL ONLINE CERTIFICATION COURSES**
NPTEL

Introduction to Internet of Things



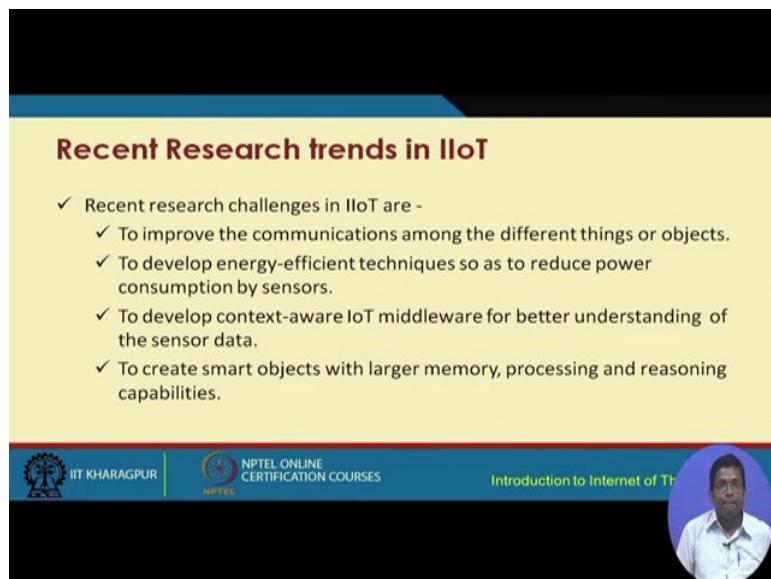
So, this is a solution that they have developed a product that they have developed it is known as control which offers IO link to the master gateway. So, it can be easily integrated into the industrial network with existing and new installations, it supports Ethernet and IP and also supports the mod bus TCP. So, there are different benefits of IIoT improving the connectivity among devices improving efficiency updating the scalability.

(Refer Slide Time: 21:42)



So, easily one can scale up by the use scale up in the industrial sector industrial processes can be scaled up, industrial you know overall industrial productivity can be scaled up through the use of IIoT reduction in the operation time can be achieved in the industry through the use of IIoT solutions remote diagnosis can be performed quite efficiently with the help of IIoT and IIoT solutions offer cost effective solutions.

(Refer Slide Time: 22:24)



In terms of the research recent research trends one is to improve the communication among the different things or objects to second is to develop energy efficient techniques. So, as to

reduce power consumption by the sensors third is to develop context aware internet of things middleware for better understanding of the sensor data and the forth is to create smart objects with larger memory processing and reasoning capabilities.

(Refer Slide Time: 22:55)

The slide has a dark blue header and a light yellow main content area. The title 'Conclusion' is in bold red. Below it is a bulleted list of requirements for IIoT systems:

- ✓ IIoT system requires the following :
- ✓ Smaller, less expensive sensors which makes them easily accessible.
- ✓ Distributed control of assembly line, automated monitoring, control and maintenance.

At the bottom, there are logos for IIT Kharagpur and NPTEL, and text indicating 'NPTEL ONLINE CERTIFICATION COURSES' and 'Introduction to Internet of Things 79'.

So, these are some of the different features the different applications of IIoT and how IIoT can improve the productivity in the industry in the different plants manufacturing plants the health care sector and so on.

So, IIoT systems they have requirement for very small sized less expensive sensors which are easily accessible and so, this basically will help in the furthering the use of IIoT more in the industry then the second thing is the assembly line. So, you know controlling the assembly line automates monitoring control and maintenance of the industrial processes and the industrial product lines these can be achieved efficiently with the help of industrial IoT.

(Refer Slide Time: 23:57)

References

- ✓ Daniele Miorandi, Sabrina Sicari, Francesco De Pellegrini, Imrich Chlamtac, Internet of things: Vision, applications and research challenges, *Ad Hoc Networks*, Volume 10, Issue 7, September 2012.
- ✓ <http://internetofthingsagenda.techtarget.com/definition/Industrial-Internet-of-Things-IIoT>.
- ✓ Ning Lu, Nan Cheng, Ning Zhang, Xuemin Shen, Jon W. Mark, Connected Vehicles : Solutions and Challenges, *IEEE Internet of Things Journal*, Vol. 1, No. 4, August 2014.
- ✓ Zhibo Pang, Qiang Chen, Junzhe Tian, Lirong Zheng and E. Dubrova, Ecosystem analysis in the design of open platform-based in-home healthcare terminals towards the Internet-of-things, 2013, 15th International Conference on Advanced Communications Technology (ICACT), PyeongChang, 2013.
- ✓ Wei Qiuping, Zhu Shunbing, Du Chunquan, Study On Key Technologies Of Internet Of Things Perceiving Mine, *Procedia Engineering*, Volume 26, 2011.
- ✓ Bill Karakostas, A DNS Architecture for the Internet of Things: A Case Study in Transport Logistics, *Procedia Computer Science*, Volume 19, 2013.
- ✓ Ying-cong Zhang, Jing Yu, A Study on the Fire IOT Development Strategy, *Procedia Engineering*, Volume 52, 2013.

IIT KHARAGPUR | **NPTEL ONLINE CERTIFICATION COURSES** | **NPTEL** | **Introduction to Internet of Things** | 10

So, these are some of the references and these can be you know. So, this reference is good for understanding connected vehicles it was published in the IEEE Internet of Things and this is something that I should mention that on internet of things there is a journal which is called the IEEE Internet of Things journal which has number of papers on the different aspects of industrial internet of things.

(Refer Slide Time: 24:45)

References

- ✓ J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, Internet of things(IoT): A vision, architectural elements, and future directions, *Future Gen. Comput. Syst.*, vol. 29, no. 7, 2013 .
- ✓ D. Bandyopadhyay and Jaydip Sen, Internet of things: Applications and challenges in technology and standardization, *Wireless Personal Communications* 58.1 (2011).
- ✓ Industry 4.0, The Industrial Internet of Things, by Alasdair Gilchrist
- ✓ <http://pdfserv.maximintegrated.com>
- ✓ <http://www.comtrol.com>
- ✓ <http://www.mcrockcapital.com>
- ✓ <http://web.stanford.edu>
- ✓ <http://www.accenture.com>

IIT KHARAGPUR | **NPTEL ONLINE CERTIFICATION COURSES** | **NPTEL** | **Introduction to Internet of Th** | 

So, this concerns basically in transportation sector like this there are different other problems and solutions mining related papers are also available, safety related papers on the use of IIoT

are also available. So, these are the different references. And so, with this we come to an end of the discussions on industrial IoT.

Thank you.