

**Introduction to Industry 4.0 and Industrial Internet of Things**  
**Prof. Sudip Misra**  
**Department of Computer Science and Engineering**  
**Indian Institute of Technology, Kharagpur**

**Lecture - 21**  
**Basics of Industrial IoT: Industrial Processes – Part 2**

In the previous lecture, in the part one of industrial processes, we have gone through the different functional aspects of industrial processes, the different attributes of smart factories particularly from a process point of view. In this lecture, some of the case studies of the implementation of Industrial IoT in the industrial processes. So, brief case studies, which all different companies have already implemented Industrial IoT in their different production processes manufacturing processes.

We will go through some of the examples, and that will be at a very high level and each industry has its own in depth understanding about how it has done the different implementations and deployments and so on. So we will just go through some of these snapshots to understand at a very high level, how which all companies and which all companies have adopted the IIoT. So, these things we are going to get a high level understanding about.

(Refer Slide Time: 01:43)

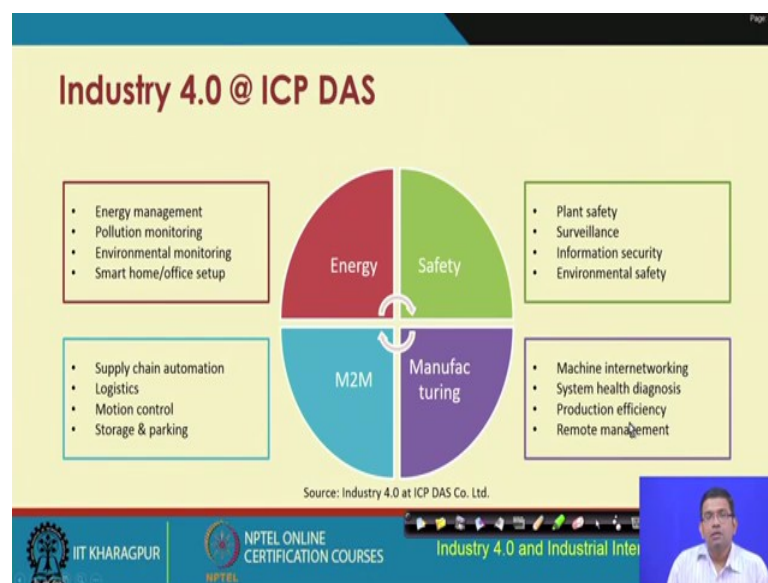


So, when we talk about Industry 4.0, there are different perspectives, there are different sectors, that will need to be considered. Smart robotics is very important, in the context

of IIoT, industries in general robotics is very important. Machineries are robotic equipped. So, basically these machines are run autonomously and in most cases, there is no human intervention; and even if there is human intervention, it is minimal. So, smart robotics is widely deployed and used in different industries.

And second is factory of future, intelligent manufacturing, smart warehousing, air-as-a-service. Air-as-a-service is a term that was coined by one of these industries we will go through shortly. So, here basically it is air compressor that we are talking about making it smart, making a air compressor smart and we will look at it in further more detail, improved mining, smart logistics, and tracking and tracing. So, in all of these different sectors IIoT has been already used and their machinery, their different processes in manufacturing and carrying on different other activities in these industries these have been made smarter, with the help of incorporation of IIoT.

(Refer Slide Time: 03:13)

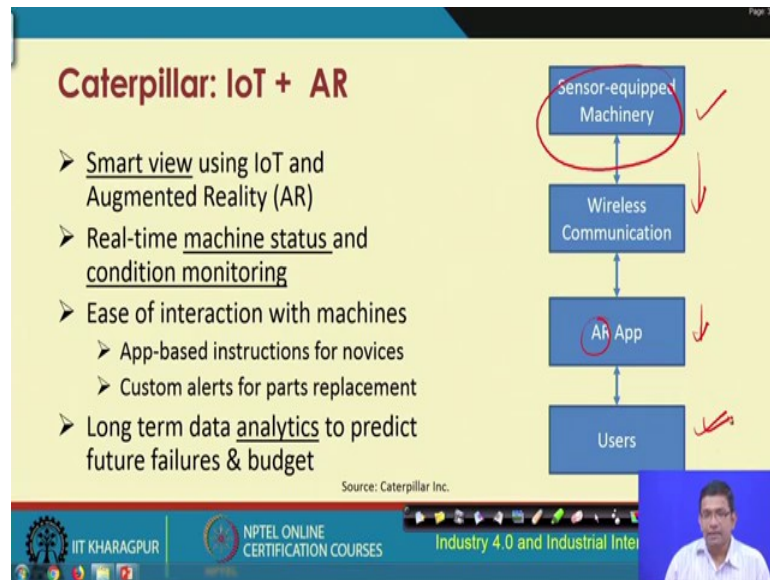


So, there is this company ICP DAS, what they have done is they have different sectors. So, they have the energy sector, M2M, manufacturing sector, and safety. And they have incorporated Industry 4.0 in each of these different sectors. So, basically in the energy sector they have incorporated, Industrial IoT solutions for energy management, pollution monitoring, environmental monitoring, smart home and smart office setup.

In the context of M2M, supply chain automation, logistics, motion control, storage and parking. In the context of manufacturing, machine internetworking, system health

diagnostics, system health monitoring, production efficiency, remote management and so on. In the context of safety, plant safety, surveillance, information security, environment safety, so these are the different domains, sectors, in which this company ICP DAS has been working for incorporating IoT solutions to make it Industry 4.0 compliant.

(Refer Slide Time: 04:37)



The company Caterpillar, and I think most of you are already familiar with this company Caterpillar. This is in the heavy machinery domain; this company has different products in the heavy machinery domain. And so Caterpillar basically has implemented IoT and augmented reality solutions and that is basically a step forward towards Industry 4.0. So, basically what happens is with the use of IoT and augmented reality, one is able to get a smart view about the real-time machine status and the condition of the machines of the different machines that they have. So, basically they have made these machines that they produce smarter.

So, real-time machine status monitoring can be done their, their conditions can be monitored and so on with the help of IoT and augmented reality. So, basically these machines are also interconnected, and they send different data from one point to another. And all these data are also made available through different apps in the form of different instructions or these different data are made available to the users. And this data can be used for further prediction to predict future failures, and if there is any budget issue and so on.

So, so, basically what they have is sensor-equipped machinery, these smart heavy machineries that are sensor-equipped, actuator-equipped and these sensor-equip machinery throw in lot of data, which are sent through a network typically wireless network. And there is a AR app Augmented Reality app and augmented reality, we have discussed it in another lecture what is augmented reality we have already understood it. So, they have an AR app. And finally, the users are able to get access in a smarter way, they are able to get access and view the system, that they are using.

(Refer Slide Time: 06:57)

The slide is titled "Amazon: Smart Warehousing" in a bold, dark red font. It features a bulleted list of key points: "Logistics & supply chain management" (with sub-points for "Smart control of supply fleet" and "Logistic status update with future market demand"), "Tech-drivers:" (with sub-points for "Warehouse Automation" and "Human-Machine Interaction"), "Robot-equipped goods storage & pickup facility in warehouse", "Lower operational cost", and "Faster operating time". At the bottom of the slide, there is a source attribution: "Source: Industry 4.0 at ICP DAS Co. Ltd.". The slide also includes logos for IIT KHARAGPUR and NPTEL ONLINE CERTIFICATION COURSES, along with the text "Industry 4.0 and Industrial Internet of Things".

Amazon, I think everybody is quite familiar with this company Amazon, because it is quite popular in the logistics sector. So, Amazon has, every company has, Amazon also has their own supply chain. So, supply chain management, smart logistics etcetera, have been have been done by Amazon through the incorporation of IoT. So, basically smart so they are able to achieve smart control of their supply fleet, and also they are able to get the status update of their logistics with future market demand.

In the context of the smart warehousing basically they have different tech-drivers that are used technological drivers, where one is the warehouse automation and the human-machine interaction. They also have robot-equipped, good storage, and pickup facility in their warehouses. Basically all these things have been done in order to improve upon the overall operations and to have faster operating time, lower operational cost with faster operating time.

(Refer Slide Time: 08:13)



**Boeing: Efficient Manufacturing**

- Smart & digital manufacturing facility
  - Helps in assembling of millions of aircraft parts
  - Automation of assembly steps
- Lower assembly delay & response time
- Reduced errors in manufacture & assembly
- Enhanced production capability
- Tech-drivers
  - Smart glasses for fault detection
  - Sensor-equipped assembler tools

Source: The Boeing Company, "System And Method For Using An Internet Of Things Network For Managing Factory Production", US F

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Inter | NPTEL

Boeing company, it is in the aerospace sector. Boeing has its own aircrafts. Boeing has incorporated IoT in different sectors, for improving the efficiency of their different processes, the efficiency of their machines the way they operate, the, the production process, and so on. So, they have the smart and digital manufacturing facility, which helps in the assembly of millions of aircraft parts.

So, it is a smart process and this is achieved with the incorporation of different sensors and actuators. These basically this smartness in the efficiency in the manufacturing process, improves the overall efficiency in terms of lower assembly delay and lowered response time, reduced errors in the manufacturing process, enhanced production capability.

(Refer Slide Time: 09:19)

**Cisco & Fanuc: Smart Factory**

- The objective is to minimize downtime in industrial facility
- Tech-driver
  - Sensor-equipped robotic manufacturing facility
  - Cloud-based analytics
- Predictive maintenance & failure forecasting
- The system can place orders for replacing failed parts
- Zero Downtime (ZDT) system by Fanuc increases efficiency
- Connection between different production phases & accordingly refill of warehouse stocks

Source: NIKKEI Asian Review, "Boy, do Fanuc and Cisco have a deal for your factory", Online article, 22 Jan 20

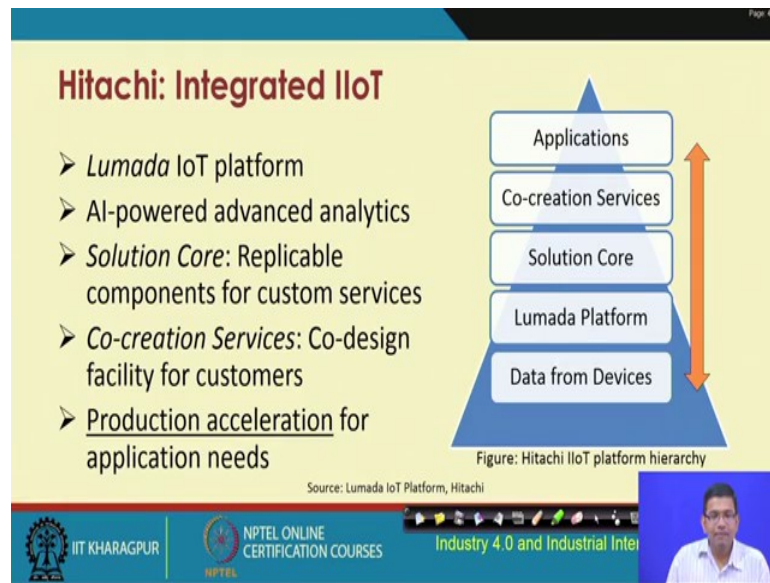
IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Intelligence

Page 4/4

Cisco and Fanuc, they are basically in the they are in the telecommunication sector. And they have developed their smart factory, where the objective is to minimize the downtime in the industrial facility. Their main tech-drivers are basically the sensor equipped robotic manufacturing facility and cloud based analytics. Basically, they are able to perform predictive maintenance and failure forecasting.

And predictive maintenance means like trying to know beforehand even before a machine fails trying to know when a particular machine would need maintenance, further maintenance, and so on. And this basically will reduce the overall downtime, because these parts can be the, the parts which are likely to be failed in the future, they can be replaced beforehand, so that the entire system does not get, does not get crippled and as we can understand that this basically will reduce the downtime of the system.

(Refer Slide Time: 10:33)



**Hitachi: Integrated IIoT**

- Lumada IoT platform
- AI-powered advanced analytics
- *Solution Core*: Replicable components for custom services
- *Co-creation Services*: Co-design facility for customers
- Production acceleration for application needs

Figure: Hitachi IIoT platform hierarchy

Source: Lumada IoT Platform, Hitachi

The slide features a pyramid diagram with five levels: Applications at the top, followed by Co-creation Services, Solution Core, Lumada Platform, and Data from Devices at the base. A vertical double-headed orange arrow is positioned to the right of the pyramid, indicating bidirectional flow or interaction between the layers.

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Intelligence

Hitachi is a company that is well understood and well-known. And this company is also incorporating integrated IIoT solutions. They have the Lumada IoT platform and this platform is the key driver in their IIoT solution. So, this platform provides AI based Advanced Analytics, which can help in predicting a particular thing is going to happen in the future and then taking requisite actions.

The other platform the other component that they have in their IIoT platform is the solution core, which has replicable components for custom services. So, essentially through the integration of IIoT solution what they want to achieve is the production acceleration. So, depending on the user needs, depending on the application needs, they are able to produce efficiently, but in an accelerated fashion, whatever they are producing in the market.

(Refer Slide Time: 11:41)

**John Deere: Precision Agriculture**

- On-board GPS for real-time tracking of agricultural equipment
- Telematics technology for forecasting & maintenance
- Bale mobile app for geo-tagged yield mapping & bale monitoring
- Implementing remote control of tractor navigation
- The future goal is to enable autonomous agricultural operations without human intervention by self-driving tractors

Source: Agriculture Technology, Precision Agriculture, John Deere

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Internet of Things

John Deere is a company which is in the agriculture space. They have equipments which are basically different machinery, which can be used like tractors etcetera, which can be used for precision agriculture and these heavy machinery, that are produced by them traditionally, John Deere. So, these machineries are equipped with different sensors and different other devices like GPS, for real-time tracking, understanding the overall health of these machines, telematics solutions are deployed by them. And these telematics solutions can help in forecasting maintenance.

And they also have the bale mobile app the bale mobile app is used for geo-tagging and yield forecasting. They also have different solutions for making the tractors smarter, for example, having some kind of remote control equipment attached to the tractors for aiding in their navigation. Nowadays they are also working on coming up with self-driving tractors, so something very similar to the self-driving cars, self-driving tractors.



(Refer Slide Time: 13:03)

The slide features a yellow background with a blue header and footer. The title 'Kaeser Kompressoren: Air-as-a-Service' is in a bold, dark red font. Below the title is a list of five bullet points, each preceded by a right-pointing arrowhead. The text is in a dark grey font. At the bottom of the slide, there is a small video inset showing a man in a white shirt speaking. The footer contains logos for IIT Kharagpur, NPTEL Online Certification Courses, and the course title 'Industry 4.0 and Industrial Intelligence'.

**Kaeser Kompressoren: Air-as-a-Service**

- Sensor-equipped air compressors
- Ease of predicting the future failures and maintenance cost
- *Air-as-a-Service*: Users pay per cubic meter of air from company's owned compressors
- Service models: *Selling, Renting, and Air-as-a-Service*
- Operation cost reduction as lesser customer services requests are generated

Source: Kaeser Kompressoren – Service

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Intelligence

This is this air as a service, which is being worked upon by Kaeser Kompressoren, which is a company which is into the manufacturing of air compressors. So, their air compressors are basically sensor-equipped, nowadays, most many of these air compressors are sensor-equipped, which is in the prediction of future failures. And the this again basically will help in reducing the downtime and saving some of the maintenance cost that is typically high in this particular in, this particular market segment. So, air-as-a-service is basically where users are able to pay per cubic meter of air from these companies own compressors. So, this is a facility that they are providing air-as-a-service. Based on the units of usage, the company earns the revenue.

(Refer Slide Time: 14:09)

**Real-Time Innovations: Smart Grid**

- Smart energy management system with *Connex DDS*
- Integrated apps and devices – scalable, secure & reliable
- Modular design, faster connectivity, high throughput
- Facility for deploying analytics in edge or cloud
- Product suite
  - Professional version: End-to-end solution, scalable & reliable
  - Secure version: Enhanced & secure version
  - Micro version: Specifically for resource constrained systems
  - Cert version: Safety-centric IIoT systems

Source: Real-Time Innovation Products

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Intelligence

RTI, Real-Time Innovations is another company, which is into the smart energy management space. And they have a solution, which is the Connex DDS, which has different apps and devices and. These apps and different devices, they collect all these different data from the different equipments. And based on this, the different analytics are performed, either at the edge or at the cloud. These data and the analysis of the data basically help the users in acting and making different performing different actions, in a smarter way.

(Refer Slide Time: 14:53)

**Komatsu: Improved Mining**

- Technology sectors
  - *Mining Intelligence*: Higher profit by predictive machine performance analysis
  - *Proximity Detection*: Enables workers to stay safe from hazards & large machines
  - *Environmental*: Reduced dust, ignition – increased visibility, optimal use of water
- Tech-driver:
  - Internet connected robots
  - Self-driving trucks
  - Wireless sensors
- Systems
  - PreVail remote health monitoring system
  - JoyConnect
  - Longwall 3D Visualization

Source: Komatsu

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Intelligence

Komatsu is a company, which is into heavy machinery in the mining sector. And their equipments are also made smarter in terms of introduction of different sensors and actuators. And they also use the data that are collected from their different machinery for performing different intelligent actions; intelligent actions which can lead to higher profit by predictive machine performance analysis.

So, they are also into they are also addressing the issue of environment, which will basically, which is basically the use of IoT solutions for reduced dust and ignition, and improving the visibility in the operations, increasing the visibility in the operations of these machinery. Their machinery are internet connected, they are basically robotic internet equipped machinery. They have self-driving trucks, where there are different wireless sensors, that are deployed in them.

(Refer Slide Time: 16:09)



The slide is titled "Rio Tinto: Futuristic Mining" and lists several key technologies and systems used in mining. The content is as follows:

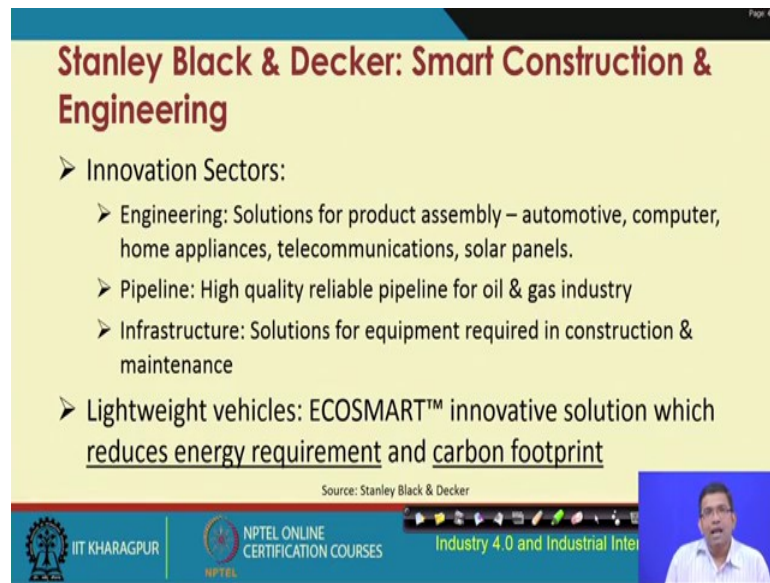
- Central control facility with visualization & collaboration tools
- Real-time monitoring and optimization of supply chain
- Autonomous haulage systems (AHS): a fleet of autonomous trucks
- Safe & efficient navigation resulting in increased productivity
- Automated drilling system (ADS): Enables remote operator to control drilling
- AutoHaul® is the system for autonomous trains to carry iron ore

Source: Rio Tinto – Mine of Future

The slide footer includes the IIT KHARAGPUR logo, NPTEL ONLINE CERTIFICATION COURSES logo, and the text "Industry 4.0 and Industrial Intelligence". A small video inset shows a man speaking.

Another company in the mining sector is the Rio Tinto, which has the central control facility with visualization and collaboration tools. They have the capability of real-time monitoring and optimization of the supply chain. So, they have different systems the autonomous haulage system - AHS, which is a fleet of autonomous trucks. The automated drilling system ADS, which enables in the remote enables in the remote operations, in the control draining drilling in the mining space.

(Refer Slide Time: 16:47)



**Stanley Black & Decker: Smart Construction & Engineering**

- Innovation Sectors:
  - Engineering: Solutions for product assembly – automotive, computer, home appliances, telecommunications, solar panels.
  - Pipeline: High quality reliable pipeline for oil & gas industry
  - Infrastructure: Solutions for equipment required in construction & maintenance
- Lightweight vehicles: ECOSMART™ innovative solution which reduces energy requirement and carbon footprint

Source: Stanley Black & Decker

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Intelligence

Another company is the Stanley Black and Decker company, it is in the smart construction and engineering sector. So, here also they have different solutions, in terms of incorporation of IoT. In the innovation sector basically, they have solutions for product assembly, automotive, then computer, home appliance, telecommunication, solar panels and so on.

Then for pipeline monitoring high quality reliable pipeline for oil and gas industry and for infrastructure solutions for equipment, which are required in construction and maintenance. They are also gradually into the lightweight vehicles space, they have the eco-smart innovative solution, which basically helps in reducing the energy requirement and the overall carbon footprint.

(Refer Slide Time: 17:47)

**Shell: Smart Oil & Gas**

- Digital oil field: Sensor-equipped oil & gas machinery, valves and pumps
- Enabling precise operation for shale gas recovery
- Real-time monitoring and optimization facility
- Faster production decisions to reduce slower production rate
- Improved production, reduced downtime & risk, lower costs

Source: Shell – Energy & Gas

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Intelligence

Page 4/4

Shell is a very well known company worldwide. It is in the oil and gas sector, supply of oil and gas. And they have now also transformed themselves into smarter solutions. They have smarter solutions for the supply of oil and gas. They have the digital oilfield, where basically you have number of different sensors that are equipped that are deployed basically in these different machinery that are used in oil and gas. So, they also have smarter valves, smarter smart pumps and so on, which are used to pump out oil from the different fields, in which these different machineries are deployed.

(Refer Slide Time: 18:39)

**North Star BlueScope: Industrial Safety**

- Worker death rate due to work-related disease/accident: ~1/15 seconds [Source: International Labor Organization]
- Wearable safety gadgets for industrial workers
- Analytics & IIoT: hazardous condition monitoring, work environment safety
  - Enforcing proper safety conditions
  - Interconnected workers

Source: International Labor Organization; North Star BlueScope

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Intelligence

Page 4/4

North Star BlueScope, this company is into the industrial safety space. Industry-related work-related deaths are very common, and is increasing every day. So, here is some statistic one death occurs every 15 seconds due to different accidents in the industry. So, this particular company is working on coming up with smart wearable safety gadgets, which can be used by the industrial workers to improve upon the industrial safety.

(Refer Slide Time: 19:27)



**Maersk: Smart Logistics**

- IoT and analytics to optimize the route & fuel consumption for containers
- Remote control & maintenance of containers according to its content – dry cargo, refrigerated cargo, or special cargo
- Facility for users to remotely monitor the condition inside cargo
- End-to-end shipment: Source to destination shipping covering intermodal transport
- Trade finance: Solution to control the flow of goods & optimize pricing
- Other solutions: *Supply Chain Optimization & Freight Forwarding*

Source: Maersk Solution

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Internet of Things

Maersk is basically a company in the smart logistics domain. It has different solutions which are IoT enabled, which used analytics to optimize the route and fuel consumption for containers. So, they have the remote control and maintenance of containers, according to the condition of these different containers. These containers are basically made smarter and they can be monitored remotely. So, they have the dry cargo, refrigerated cargo or, special cargo. And each of these different types of cargoes can be monitored and can be maintained remotely through the use of these smart equipments that are deployed in them. So, they have the smart logistics solutions.

(Refer Slide Time: 20:13)

**Magna Steyr: Smart Factory**

- Digital mapping of entire production timeline
  - Vehicle engineering
  - Production line implementation
- Intelligent production system: Accurate, scalable, reliable & dynamic to changed needs
- Full autonomy of factory: network of humans, machines & resources
- Solutions: *Driver assistance system, Alternative energy storage system, Lightweight design & joining system*

Source: Magna Steyr – Capabilities

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Internet of Things

Magna Steyr is in the smart factory domain, where they have digital mapping of entire production timeline. So, they have vehicle engineering solutions, product production line implementation solutions, and the intelligent production systems are developed by them, which can be help in achieving accuracy, scalability, reliability and also being able to change in terms of the dynamic requirements, change in the dynamic requirements. And they also have the full autonomy of factory, they have a network of humans, machines and resources, they have solutions like driver assistance system, alternative energy storage system, lightweight design, and joining system.

(Refer Slide Time: 21:05)

**Gehring: Connected Manufacturing**

- Internet-connected sensor-equipped machinery enables real-time data streaming
- Smart projection of machine functionalities to customers in real-time: precision & efficiency check
- Cloud-based analytics to reduce production downtime & increase productivity
- Provision for real-time tracking & monitoring of machinery
- Facility for data visualization & additional analytics

Source: Gehring Technologies

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Internet of Things

Gehring is in the space of connected manufacturing. Here they have different manufacturing systems which are internet-equipped, these are sensor-equipped and these systems basically in real-time they throw in lot of data, they stream in lot of data. So, they have smart projection of missing functionalities to customers in real-time, which basically helps the customers to know in real-time, what is happening with these different systems. So, this basically helps in improving the efficiency and improving, improving the precision.

(Refer Slide Time: 21:45)



**Bosch: Track & Trace Innovation**

- Solution to ease the searching of the different tools/parts in a factory
- Sensor-equipped tools/parts can be tracked and traced
- Reduction in searching time and risk for using wrong tools
  - Asset/work management
  - Integrated manufacturing
- Future impact: Can help in automated sequencing of assembly operation
- Tools-as-a-Service: New business model for efficient productivity, enhanced safety & product quality
- The same technology can be applied to many other sectors of the industry – food, logistics, supply chain, pharmacy, etc.

Source: Bosch Track & Trace Innovator

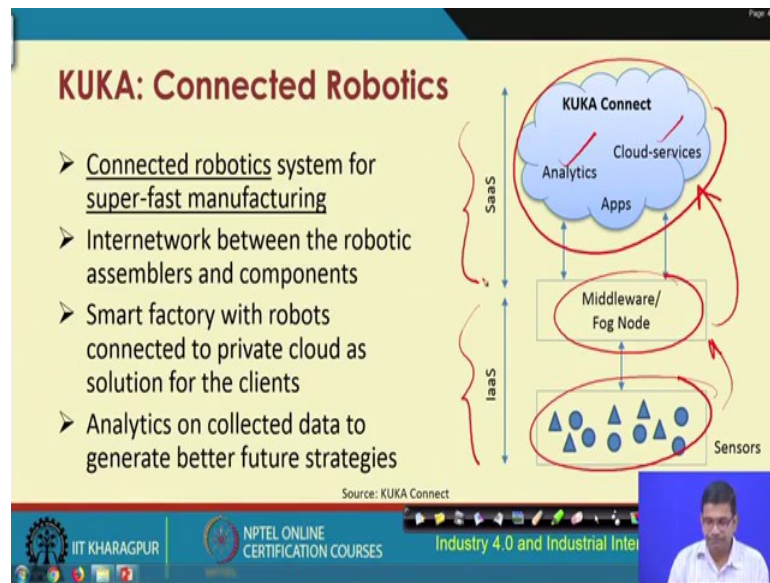
IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Industry 4.0 and Industrial Intelligence

Page 4 of 4

Bosch has a very intelligent solution for tracking and tracing of different parts machine parts different other goods and so on. So, these basic the solution that they have is also sensor-equipped, and they can be these tools and parts can be tracked and traced, there is reduction in searching time, and risk for using wrong tools. So, basically their solutions will help in improving, the asset management, work management, improving the manufacturing processes, because everything is integrated, its integrated manufacturing. They also have a tools as a service solution, which is a new business model, which can help in improving the efficiency of productivity, enhancing the safety, and improving product quality.

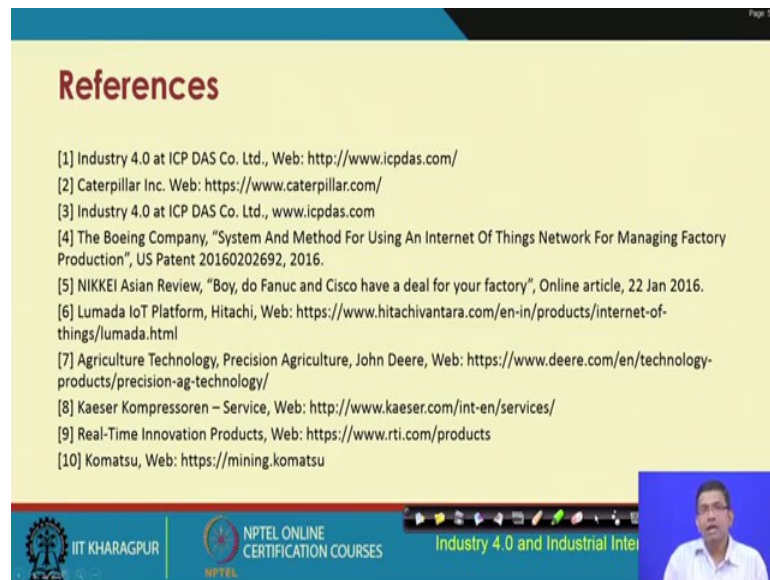


(Refer Slide Time: 22:35)



KUKA is a company, which is into the connected robotics domain. So, they have systems, which are connected robots that can be used for improving the manufacturing process, so improving the time that it takes for manufacturing. So, they have super fast manufacturing processes through, the use of connected robotics and this is the KUKA architecture. They have all these different sensors at the very bottom, then there is the middleware and the fog node. Basically, the fog node is the one, which will take the data and process it locally close to the source, close to the source means close to the sensors. And all the other data are going to be sent to the cloud for performing different analytics and so on at the cloud. So, they have a combination of infrastructure-as-a-service, and software-as-a-service solutions.

(Refer Slide Time: 23:35)



**References**

- [1] Industry 4.0 at ICP DAS Co. Ltd., Web: <http://www.icpdas.com/>
- [2] Caterpillar Inc. Web: <https://www.caterpillar.com/>
- [3] Industry 4.0 at ICP DAS Co. Ltd., [www.icpdas.com](http://www.icpdas.com)
- [4] The Boeing Company, "System And Method For Using An Internet Of Things Network For Managing Factory Production", US Patent 20160202692, 2016.
- [5] NIKKEI Asian Review, "Boy, do Fanuc and Cisco have a deal for your factory", Online article, 22 Jan 2016.
- [6] Lumada IoT Platform, Hitachi, Web: <https://www.hitachivantara.com/en-in/products/internet-of-things/lumada.html>
- [7] Agriculture Technology, Precision Agriculture, John Deere, Web: <https://www.deere.com/en/technology-products/precision-ag-technology/>
- [8] Kaeser Kompressoren – Service, Web: <http://www.kaeser.com/int-en/services/>
- [9] Real-Time Innovation Products, Web: <https://www.rti.com/products>
- [10] Komatsu, Web: <https://mining.komatsu>

The slide footer includes the IIT Kharagpur logo, NPTEL ONLINE CERTIFICATION COURSES logo, and the text "Industry 4.0 and Industrial Intelligence". A small video inset in the bottom right corner shows a man speaking.

With this we come to an end of this lecture. So, these are some of these references that are used. And so what we have done is we have gone through an assortment of different, different solutions that are there in the industries. And if you are interested this was just a glimpse a highlight of these different solutions that are there in the different industries. And many of these in are in the works, the industries are transforming two Industry 4.0 gradually and these are in the works.

So, if you are interested please feel free to visit these company websites to, to know more about their systems, their smarter systems, and so on. So, with these are the different references and with this we come to an end.

Thank you.